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MACHINERY:

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A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:

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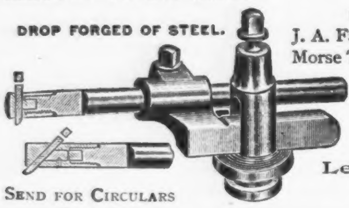

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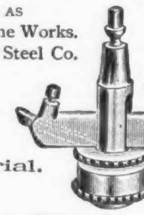

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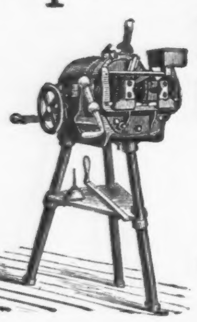

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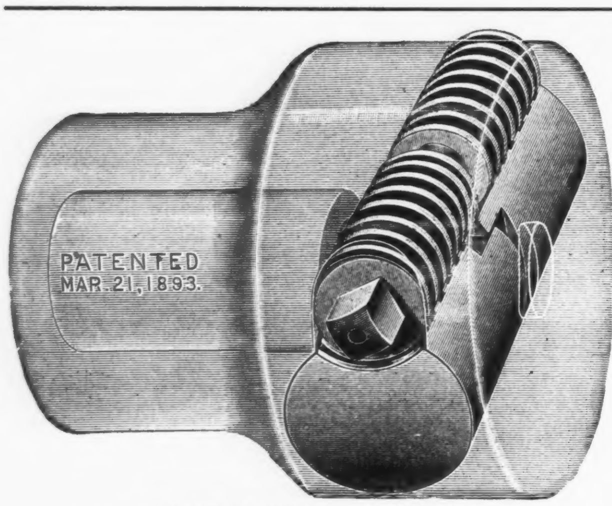

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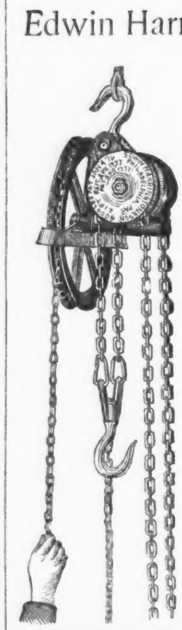

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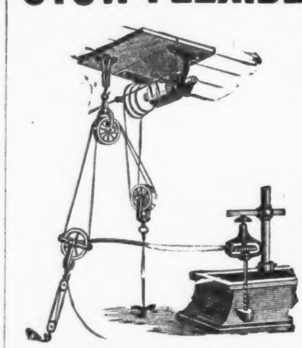

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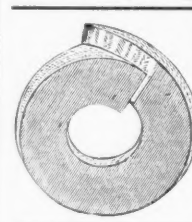

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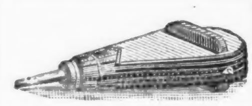

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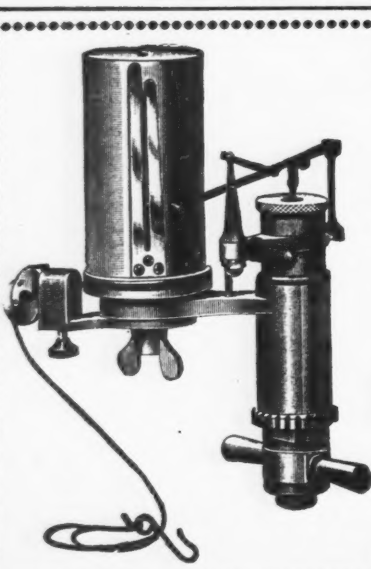

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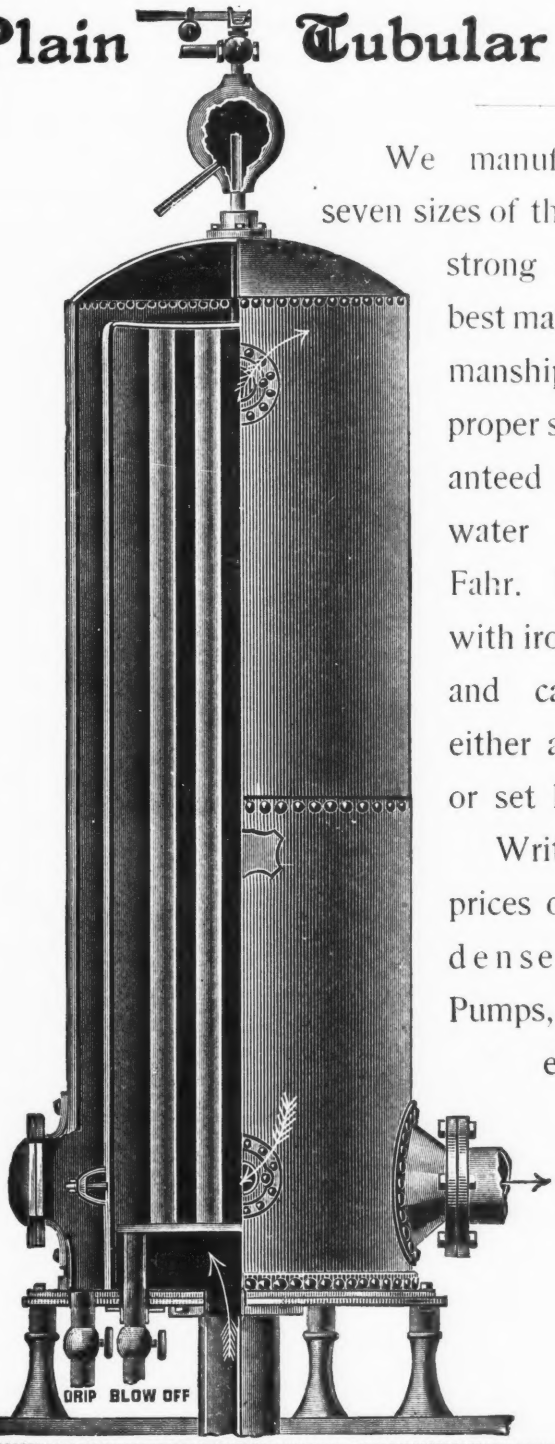

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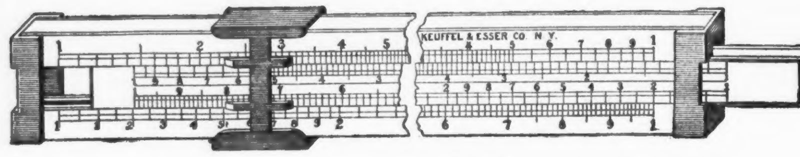

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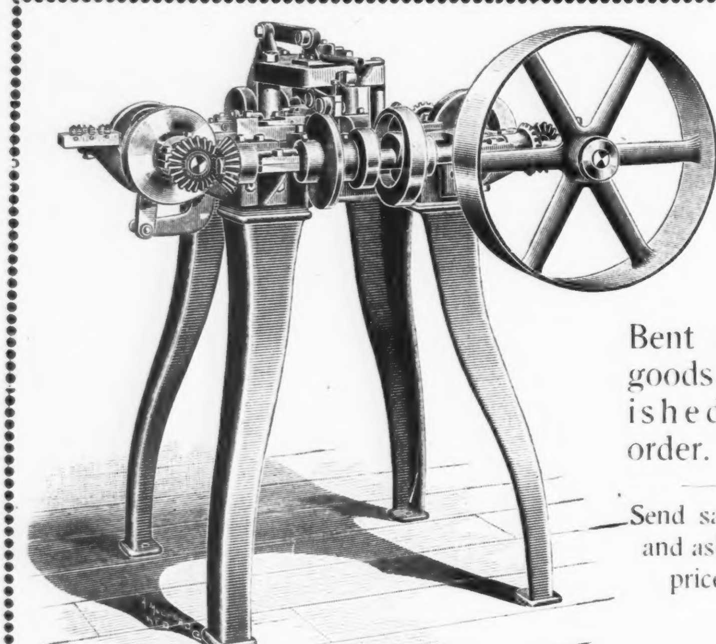

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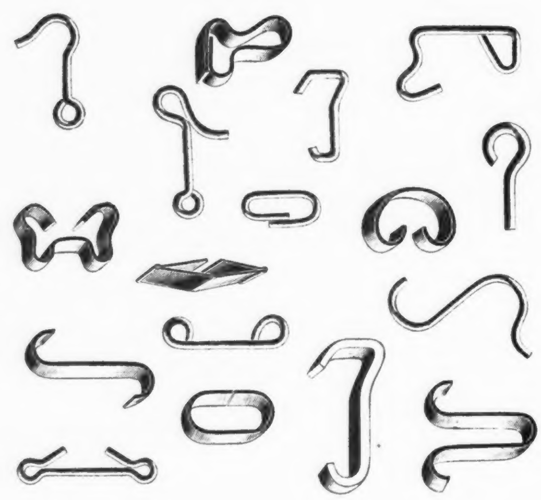

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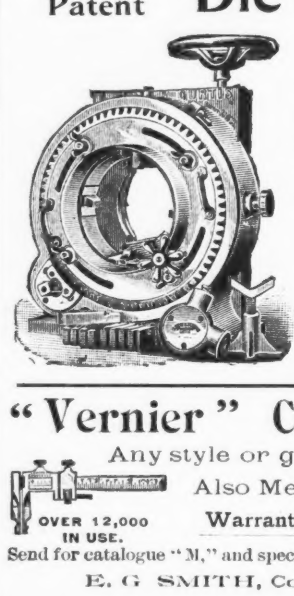

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MACHINERY.

Vol. I. January, 1894. No. 5.

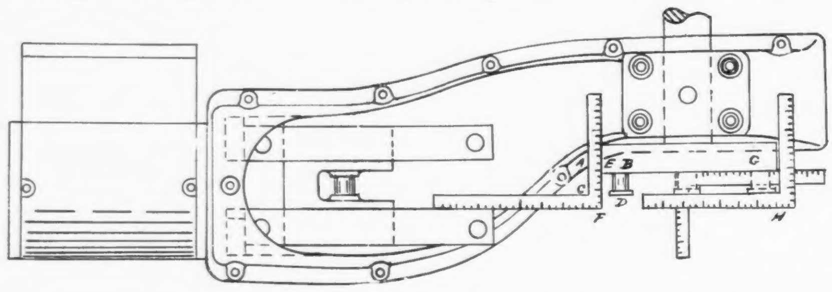
TALKS TO YOUNG ENGINEERS.

Wm. O. Webber.

THE average engineer should post himself on the details of construction of the engine under his charge, and should study to make himself thoroughly familiar with such details in every engine with which he may be brought in contact. Too much cannot be said in regard to an engineer's real position towards his employers and the industry with which he may be connected. It is not sufficient that he should simply content himself with keeping his engine oiled and clean, his fires clear and his boiler full of water; his duties go a deal further than that. In many cases he is and should be the representative mechanical man about the concern; and a truly good engineer, one who has his own and his employer's interests fully at heart, and they should be nearly identical, will not be contented, and should not allow any man about the premises to know more about his engine than he does. Books on steam engine design and construction, etc., are so cheap now and are written in such simple language that they may be had or comprehended by a man of ordinary intelligence and means, and almost every mechanical engineer with which the writer has come in contact is more than willing to give such a man considerable valuable information. Good reliable steam engine indicators, reducing wheels, planimeters, etc., can now be obtained at very reasonable figures, and there is no reason why every engineer should not own his own set. The steam engine is really a very simple piece of mechanism, although susceptible of almost infinite development and involving many very intricate problems. The engineer in charge can go into these as little or as much as he pleases, and let me insist that no matter how far he may study into such problems, he is never quite likely to "know it all," but nevertheless he is always fitting himself to know more and enhancing his chances to secure the charge of a higher type engine than that he has at present, and with consequently larger pay. A great many young men are loth to make a start, saying that they have no instruments, no books and no one to show them. But do they always appreciate the few instruments at their command or which they can improvise? One of the very best qualities which can be developed in a young mechanic, or man of a mechanical mind, is to see what he can improvise to help himself with. The old story book of Robinson Crusoe illustrates and demonstrates how a man who has "got it in him," although thrown on a desert island, can develop what is thrown in his way and really produce not only comfort, but a kind of luxury, by using his brains to help out his hands. Almost any engineer can become possessed of a common two foot carpenters' square, while a piece of fine cord and a nut if you please will make a plumb bob; and with these two instruments he can "line up," or ascertain whether his engine is in line and the crank square, etc.; straight edge and carpenters' level will tell him whether his engine is level all over. Half of the engines that "pound" so that they can be heard a block away do so from being out of line and level, and it is not even necessary to remove the piston, or any part in fact, from a side crank engine, to demonstrate whether it is in line or not. This piston is pretty sure to follow the bore of the cylinder and the slides, to be in line therewith, and the square laid along the sides of the guides, with the plumb line dropped over the crank-pin in the extreme forward and back positions, will tell the story. An engineer who can demonstrate to his employer by his use of these simple means his efficiency and right to be in charge of an engine, can soon get permission to drill his cylinder for indicator holes, if not to buy an indicator at the firm's expense; and whenever he has the latter instrument his chances for showing what he is made of are improved a hundred fold, for he can then show that his engine was "out of square," using more steam and wasting power working against itself, perhaps had excessive clearance, which may be taken up in part, and many similar things, which might be as easily remedied and work as beneficial results to himself as to his engine.

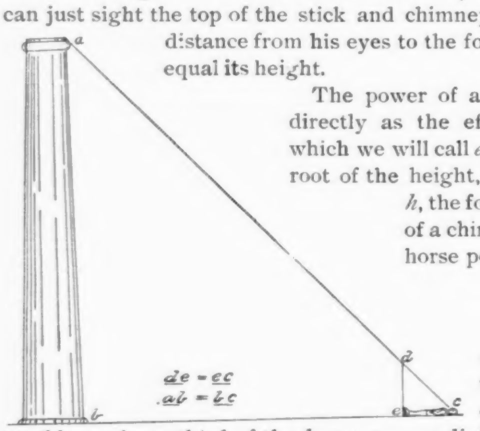
Another field, fully as profitable, is in connection with the boilers under his charge. Very few boiler-rooms, except in the most modern plants recently erected by competent engineers, are even in "comparatively" good order. This is not due to any lack of attention by those in charge or those principally interested, but usually because they have outgrown and outworn their original design. For instance, a party originally puts in a couple of boilers and builds a stack to accommodate them. After a year or so he puts in another boiler which the same stack has to take care of, and a few years later a fourth boiler. This time the stack "kicks," but nobody knows what or where the matter is until some "smart Aleck" comes along and says, "Oh, build the stack up ten feet

higher." This helps a little, but is not the way to do it; in other words, you cannot make a hole any larger by making it longer. Now, our thinking engineer can find out the area of his stack without much trouble, by crawling in at the ash door at the bottom; also the area of his flues, and can readily calculate the area of his grates. These things should all be in due proportion, and he can get the height of his chimney by cutting a stick which is



Measurements from square to either end of crank-pin at A B and C D; also from face of crank disc to edge of square at E F and G H. Plumb line dropped over pin in top and bottom will strike position to square laid on floor, square being lined from edge of slides. Square can be clamped to straight edges to prolong them.

exactly as long as from his feet to the center of his eyes, lying down on the ground with the stick vertically at his feet until he can just sight the top of the stick and chimney in line, when the distance from his eyes to the foot of chimney will equal its height.



The power of a chimney varying directly as the effective area, and which we will call *e*, and as the square root of the height, which we will call *h*, the formulæ for the size of a chimney for any given horse power would be

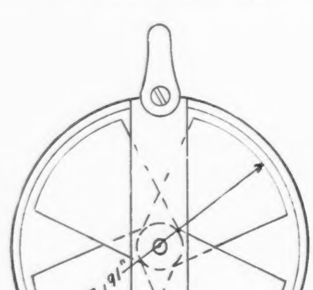
$$e = \frac{0.3 \text{ H. P.}}{\sqrt{h}}$$

which means that the area of the hole of the chimney would equal one-third of the horse power divided by the square root of the height in feet. Or, supposing we have a chimney 80 feet high and boilers of 231 horse power, then

$$\text{Area} = \frac{0.3 \times 231}{\sqrt{80}} = \frac{69.3}{8.944} = 7.76$$

square feet area.

Now for a round chimney the diameter=diameter of $e+4$ inches, or 7.76 square feet = 1117.44 square inches area=37¾+4 inches=41¾ inches, or say 42 inches. For a square chimney this formula would be side of chimney= $\sqrt{e}+4$ inches, or the square root of the area plus 4 inches, 1117.4 square inches, the square root of which would be 33¾ inches +4 inches =37¾ or 38 inches, which would be one side of the chimney.



A HOME-MADE ANEMOMETER

Now our grate surface area should be as 8 is to 1 to our chimney area for good practice, and as our grate openings should be one-half of the grate area we should have 62.08÷2= 31.04 square feet or 8939 5 square inches of grate opening.

Every pound of coal requires 18 pounds of air to get proper combustion; 18 pounds of air= 240 cubic feet. Our chimney should produce a combustion of 15 pounds of coal per square foot of grate per hour. This would be 1154.4 pounds of coal per hour, or 19.2 pounds of coal per minute, and 240 cubic feet of air to each pound of coal would be 4608 cubic feet of air required; this through our grate area opening of 31.04 square feet would require a velocity of 148.4 feet per minute of the air entering under the grate. If the ash doors and other openings were of the same size as the grate opening area, viz.: 31.04 square feet, as the usual openings are about from one-third to one-quarter of the grate openings, the velocity of the air must be from three to four times as fast, or from 445.2 to 593.6 feet per minute.

Our thinking man can make himself a simple wind-mill or anemometer*, which will give him the velocity of air, and by using this in a box in the ash-pit door, can ascertain how much air he is using per minute. If he is not using the amount his chimney would care for, his grate openings are not sufficient, or he is carrying too heavy a fire, and in either case his combustion is imperfect and he is wasting coal.

* * *

AN ATTACHMENT FOR WATER GLASS GAGES.

The use of compounds in the feed water of steam boilers to prevent incrustation has grown so much during the past few years that it is now rather unusual to find plants of any size where special solutions are not used for that purpose. Especially in large cities where the excessive cost of water supplied by the municipal mains has forced the greater number of steam users to bore wells and pump the water required for all the needs of manufacturing.

Economical as this may be as far as the actual water charge is concerned, yet new difficulties are often introduced which add to the expense of maintenance. Chemical impurities in the shape of sulphates, chlorides or carbonates are more frequently found in artesian wells than in running water, while nitrogenous impurities in surface water often prove exceedingly deleterious to the condition of the boiler sheets. Chemical analysis alone can determine the best means for counteracting these troubles, and yet even with the best care this does not prove entirely effective.

One of the disagreeable features of the use of compounds, oil or other things introduced into the feed water to prevent the formation of scale, is the frequent accumulation and deposit that occurs in the gage glasses and cocks. This accumulation—especially when oil is used—is often sufficient to so cloud and darken the glasses as to render the accurate observation of the water level extremely difficult.

A very simple method of keeping the glasses clean and one that may be new to many engineers, depends upon the well-known fact that during evaporation all solids held in solution or suspension are deposited. If the glasses and cocks can be kept filled with condensed steam, the contained water is sure to be clean and clear. To do this it is only necessary to attach to the upper cock and vertically above the glass itself, a short brass ½ inch nipple, threaded at the upper end; this can be done by removing the cap and boring and tapping for ½ inch gas pipe; to this nipple screw a ¾ by 2 inch reducing socket, preferably brass, and add a piece of thin brsss seamless tubing about 10 inches long, capped steam tight at the top. This forms a small steam condenser which allows a gradual accumulation of pure water, drop by drop, in the glass below, and which slowly passes out through the water cock into the boiler, assisting somewhat in keeping it in good condition also, although the motion of the water in the boiler counteracts the effect to some extent. If this little device is kept bright and clean, it forms an ornament to the boiler.

Details of improvement in construction will at once suggest themselves, and in fact the condensers used by the writer have been made somewhat more elaborately. But the principle embodied is precisely the same and their use has proved both a safeguard and a convenience in all cases where the difficulty of cloudy glasses has been found.

* * *

A rather unaccountable error occurred in the advertisement of the Walworth Manufacturing Company in our last issue, and "Walworth's Heavy Pipe Vise," was made to read "Walworth's Heavy Piece Pipe." The vise is so well-known that its correct name is all that need be given.

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* Anemometers can be bought at very low prices now, sufficiently accurate for this purpose, or can be constructed as per sketch, of a wooden hoop, a steel spindle with wooden wings, from four to eight or ten blades, say, to give the best results, the angle of the blades being 55 degrees. The revolutions of the blades equal the velocity of the air in feet. A clock-work counter, such as is used on gas meters, can be easily attached to spindle to give revolutions per minute.

LOOKING BACKWARD.

W. H. Booth.

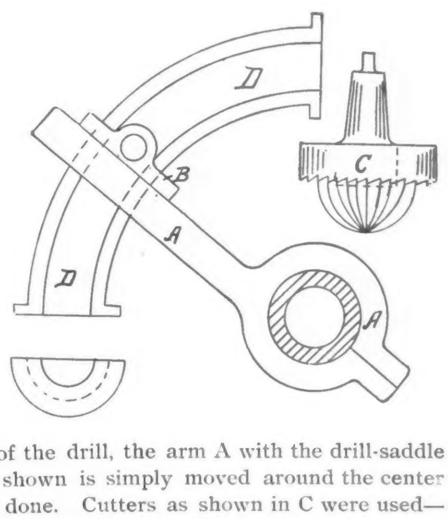
Reading the October number of Machinery, it has occurred to me that the editor has perhaps purposely written a portion of his "Looking Backward" with the idea of raising us to remonstrance. While I should like to agree with the statements of what the future engineer and fireman will not do, I feel greater hesitation in accepting what he will do, as a correct prophecy for fifty years hence. Why, for example, does a fireman so often, when steam begins to rise higher than desirable, throw open the furnace door and keep the damper open? He does this to give a free passage for air to the chimney; the air goes by the least impeded road, and therefore avoids the obstructed way offered by the grate. It short circuits itself, in fact, just as an electrical current will do by taking the shortest way. Now it has occurred to me, but I have never been able to put it into practice, that the habit is so very natural to many firemen, that an engineer, whose duty, by the way, it is to utilize the forces of nature as he finds them and not sigh for a little scheme of creation all his own, ought perhaps to take this idiosyncrasy of the fireman as one of the forces of nature with which he is called upon to deal, and provide for what he has so far found it impossible to eliminate.

I would therefore like to suggest that there may be something in my idea of surmounting the difficulty, which is as follows: To make a short circuit part and parcel of a steam boiler equipment, by providing beyond the feed water heater an opening into the main flue, closed by a well-fitting swing door, upon opening which, the air will rush in and occupy the chimney to the detriment of the draft, but greatly to the salvation of the furnace plates and the keeping warm of the feed heater and flues. Such a door could be controlled by the fireman, especially if aided by a piston in a cylinder whereby he could open or close the inlet by a simple turn of a cock. On the other side are we right to assume that the fireman does follow out the bad practice indicated from choice, or because it is simply his way of short circuiting his labor to a desired end, the correct steam pressure? If so, can we put him on a fresh circuit and an easier way, for, after all, as in the case of Potter, the boy who first made an engine actuate its own valves in order that he might go out and play, have not many genuine and desirable improvements come about from this very habit—call it laziness if you will—though these lazy men frequently make good use of the ease they contrive for themselves. I think we can and must express our surprise that it is so exceedingly general to apply dampers only to the flues. These dampers are not by any means perfect as draft regulators, as any one who has burned bituminous coal must know. Close the flue damper and you close the air off altogether—both that which enters by the grate and that which enters at the door register. Now it is absolutely essential to smoke prevention to admit some air at the door, especially just after firing, in order to combine with the hydrogens then given off the fresh charge of fuel, but if the flue damper be shut this cannot happen. What is wanted, therefore, both for smoke prevention and general regulation, is a damper that will not check the air flowing in at the door, but will check that which flows in by the grate, leaving the air flowing in by the door to be regulated by the proper register or slide in the door itself, through which, by the way, orifices for air ought to have an area of about 1½ square inches for each square foot of fire-grate surface to be sufficient for the needs of hand firing. The damper to regulate the air flowing in by the grate bars is simple and efficient, and consists of a light sheet iron door hinged to the opening of the ash-pit under the grate. Close this and the fuel on the grate ceases to burn except sluggishly, but it still gives forth hydrocarbon gases and carbon monoxide, to burn which air must still be allowed to flow in by the door. Ash-pit dampers are light, easily moved, and form perhaps the most convenient short circuit that can be put into a fireman's hands. Even for anthracite fuel they are really needed, and so also are air inlets in the doors to use when the ash-pit dampers are shut, to consume the monoxide of carbon given off by the fuel burning with a limited supply of oxygen. Once regulated for normal duty the *flue damper* need not again be moved. Should the duty of the boiler be varied then the flue damper may be varied to suit, but the general regulation throughout the day should be effected by the ash-pit dampers. People are apt to imagine that by closing the flue damper they bottle up the heat amongst the tubes of the flue feed heater, and so on, but so does the ash-pit damper equally well, for unless air be let in somewhere it is not likely to flow out at the chimney, and there is no power of suction in a chimney. The flow of gases in a chimney is but like the flow of water in a pipe uphill, due to a head or pressure pushing behind. Close the inlet, therefore, and you stop the movement of the gases in the chimney. This emphasises, however, the importance of closing *all* inlets of air, besides simply the door. Here, for example, are several hundred bad mortar joints all letting in a little air. Have them scraped out and repointed in cement, first wetting the bricks and keeping them wet for a day or two while the cement sets. Here are forty million pores in the bricks themselves. Have them smothered with tar or paint. Can you not blow a candle out by concentrating the leakage of air that comes through a few square feet of wall surface exposed to the wind on the outside? Here is a badly fitting damper frame around the flue damper. Have a guard made to check this indraft; see how clean swept is the brickwork for a few inches around this frame—the draft will allow no dust to settle there. Many a man has built himself a costly new chimney who could have carried on with the old one for the expenditure of a few cents or a dollar or two in bad cases. It is the aggregation of the leakage through the millions of little pores and few big ones that spoils the draft and particularly lowers the efficiency of the flue feed heater. But I have reached my limit, and if allowed will have something more to say on this "looking backward" in a future number.

* * *

A RADIAL DRILL JOB.

A small shop took the contract for making the tubes for a pneumatic package transmission system, using cast-iron pipe, which was required to be as round as they could be bored. The lengths were short, and this was not difficult, but the curves were the puzzling feature. It was at first decided to use a regular rose reamer on the end of a Stow flexible shaft, as the curve need not be a true arc if it was only bored round, and the reamer would follow the curvature very closely. One of the men, however, hit on the scheme of using a radial drill, as shown in the outline cut, and this was successfully done on all that were made. Clamping the curve or elbow D (which was made in halves, as shown) to the table in the correct position with relation to the center column of the drill, the arm A with the drill-saddle B, and the spindle as shown is simply moved around the center column and the job is done. Cutters as shown in C were used—being half a sphere with the facing collar attached at the correct position so as to face the elbow and leave the interior just half a circle, as shown at the end view of the curve. This principle can be applied to various uses, and by a little study many similar jobs can be done on the radial drill.



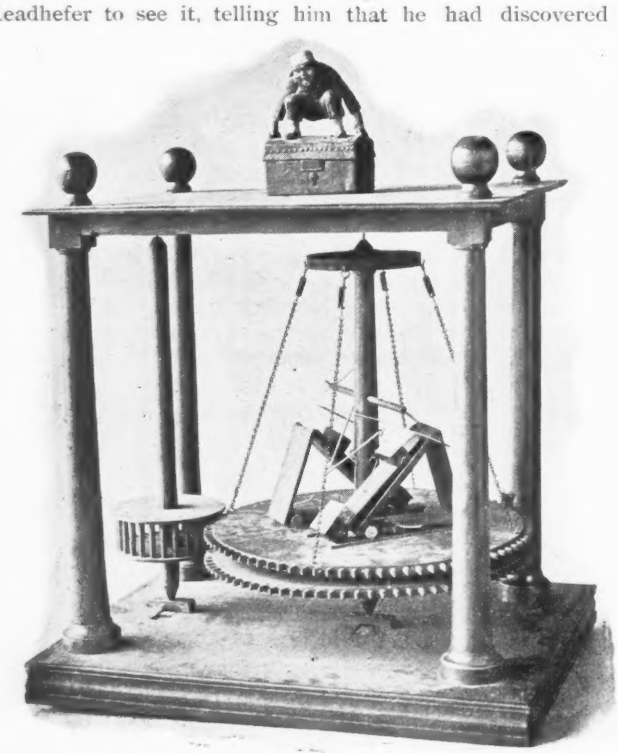
* * *

Don't promise a job two days before you know it will be done.

A PERPETUAL MOTION MACHINE.

[The recent attempts at perpetual motion, among them a wonderful wheel proposed by Mr. S. B. McHenry, of Chicago, suggested the collection and preparation of the following data.]

Of the many machines alleged to accomplish the overthrow of nature's law of gravitation and consequent friction, the one by Mr. Readhefer, illustrated below, probably attracted as much attention in its day as any machine devised. It became so prominent that the Legislature of Pennsylvania, on December 14, 1812, "Resolved, That Henry Voight, Robert Patterson, Nathan Sellers, Lewis Wernwag, Josiah White and Samuel D. Ingham be and are hereby requested to make a strict examination of the machine invented by Readhefer, and to make a specific representation respecting it, as its alleged importance and the public expectation require." Mr. Isaiah Lukens accompanied the committee, and a close investigation revealed to him and others that the inclined planes and loaded carriages, whose downward pressure on the inclined planes was supposed to force the large wheel to revolve, had nothing to do with its movement, and its uneven, jerky motion clearly indicated hand power applied at some point, afterwards found to be in the room below, where a boy was hard at work turning a crank, which drove the small gear, instead of that being driven by the larger one. Mr. Lukens then made a model of this machine, inclined planes and all, and invited Readhefer to see it, telling him that he had discovered his



fraud and asking him to detect the motive power of the model. This Mr. Readhefer failed to do, and admitted himself beaten, when Mr. Lukens showed him a clock-work concealed in the base, being wound by turning the front left-hand knob on top of the case. The model is now in the Franklin Institute of Philadelphia, to whom we are indebted for the photograph, and the figure of the man attempting to lift himself and the trunk is a fitting sarcasm, to be studied by would-be inventors in this line.

* * *

WHEN a man devises a little tool that helps the work along faster and better than before, show him you appreciate it, either by making his work easier, giving him better work, by a money consideration, or last but not least, letting him see that you consider him a valuable man with valuable ideas. He will then feel more like trying to improve other features of the work, and you will benefit thereby.

* * *

THE meter is 39.375+ inches, the decimeter 3.9375, the centimeter .39375, and the millimeter .039375 of an inch. A fair approximation can be had by calling the milimeter .04 or $\frac{1}{25}$ of an inch and the centimeter .4 of an inch, and by having some number to use as a comparator we get a better idea of the actual sizes, for 5 millimeters mean very little to us unless we think that it is about $\frac{1}{5}$ of an inch.

THE DESIGNING AND CONSTRUCTION OF MODERN STEAM ENGINES.—4.

THEO. F. SCHEFFLER, JR.

STEAM AND EXHAUST VALVES.

In order to obtain a good regulating engine, it is absolutely essential to have a well balanced valve. The number of pounds required to pull the ordinary unbalanced slide valve is enormous; lubrication is uncertain, and consequently friction is constantly changing—increasing or decreasing, according to the design of slide valve. Referring to the drawings of steam valve, Fig 17 is a longitudinal section through valve and pressure plate; Fig. 18, a plan view of both valves connected by stretcher rods; Fig 19, a cross-section through center of pressure plate and center of valve, and Fig 20 shows bottom view of valve Fig. 17 shows the valve just on the point of opening, and illustrates the distribution of steam by the arrows; steam is entering at the bottom and at the top, which will give a very high initial steam pressure and a sharp cut-off. The valve is well balanced at all points of its travel, having the pressure on bottom and top during admission of steam; during exhaust there is probably a little more pressure on top of one of the valves than at bottom, due to the small amount of steam entrapped in the pressure plate at the beginning of exhaust. It is the opinion that this steam being separated from live steam by a small partition, would have a higher pressure than the steam exhausting in the atmosphere; but as the load is constantly changing on most engines, the above pressure would also vary according to load. If we were to plot out a theoretical indicator card at some given point of cut-off, the exact amount of pressure on top of valve could be found during exhaust. During compression, the valve on that end of cylinder where compression takes place is thoroughly balanced; as the compression follows through port in valve, and between valve and pressure plate. In our last article the clearance was calculated, but nothing was mentioned of clearance in valve port and under bottom of pressure plate. The writer believes that all this volume of space cannot be called clearance, for the reason that some of the expanding steam is entrapped in valve port, and which proves to be beneficial to the incoming initial steam into cylinder ports and valve ports, by giving valve port a higher temperature, and thereby lessening condensation of the incoming steam. We will, however, figure the amount of clearance contained in valve and pressure plate. The total number of cubic inches contained in valve port after deducting out the cubic inches contained in the three rod bosses, is 53.22; the total number of cubic inches contained in pressure plate port 12.18, and adding together gives 73.42 cubic inches. this divided by 4825.44, the total volume contained in cylinder, $73.42 \div 4825.44 = .0152$, or 1.52 per cent of piston displacement contained in valve and pressure plate; the above added to the 4 per cent. clearance found in our last article gives 5.52 per cent. total clearance. It has been the writer's practice to allow only 50 per cent. of the total clearance contained in valve and pressure plate, which would make the total clearance only 4.76 per cent. of piston displacement.

The total pressure on pressure plate is found by multiplying length by breadth, which gives the area, and this we multiply by 125 pounds steam pressure. Referring to Figs. 17 and 19 we find the length of pressure plate to be 17 inches, and width 6½ inches; then $17 \times 6\frac{1}{2} = 110.5$ square inches area, and $110.5 \times 125 = 13.812.5$ pounds total pressure on pressure plate; the plate is sufficiently strong to resist this pressure equally distributed over its surface. The above pressure bears wholly on the distance pieces on each end of the pressure plate. To find the pressure per square inch on distance pieces, first find the area; the length is 6½ inches; width, 1½ inches; therefore, $6\frac{1}{2} \times 6\frac{1}{2} = 9.75$ square inches on each one, and multiplying by 2 gives 19.5 square inches area for the two distance pieces. The next step, we divide 13,812.5 by 19.5, which gives 708.3 pounds pressure on each square inch of distance pieces. The above pressure is not so large when we consider the pressure per square inch allowable on crank pins, which is all the way from 600 to 1,000 pounds. In one sense there is no comparison, because with the pressure plate there is no motion. But let us take the total steam pressure on pressure plate in another way, *i. e.*, apply it to the top of an ordinary slide valve that is unbalanced, and find the pull on valve rod in pounds. We will disregard the steam ports, and figure the valve as if it were for this engine. Width of valve, 5 inches; length, 14 inches; there-

fore, $5 \times 14 = 70$ square inches area; and, as we have two valves, we have 140 square inches area; 140×125 pounds steam pressure gives 17,500 pounds total pressure on both valves, and allowing .15 per cent. for co-efficient of sliding friction, we have $17{,}500 \times .15 = 2{,}625$ pounds pull for both valves, disregarding the weight of valves. The above pull on valve-rod would be too much for

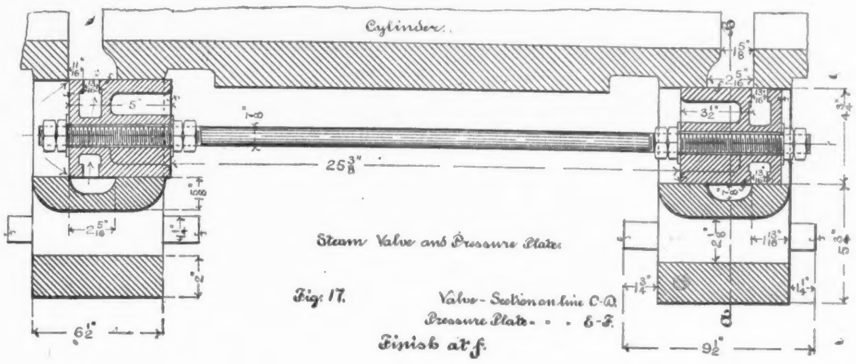


Fig. 17.

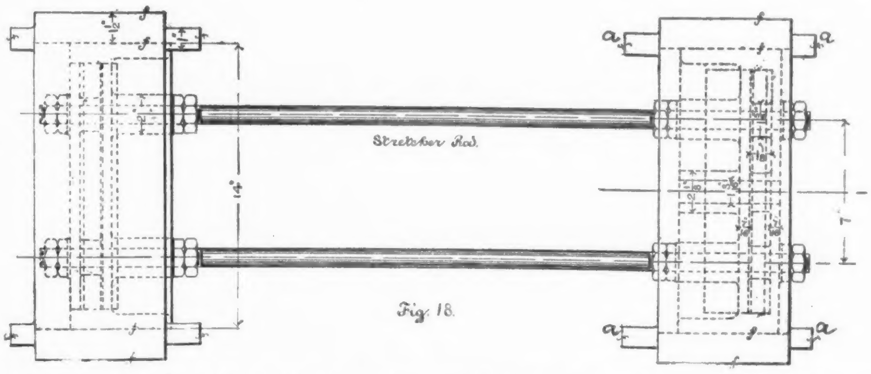


Fig. 18.

any governor to handle, besides lessening the horse power. We will compare the pull on valve-rod of the unbalanced valve with the balanced valve. To be more accurate with the balanced valve we will first calculate the weight of both valves and stretcher-rods. The total number of cubic inches of metal contained in each valve is 164.75; and as the weight of one cubic inch of cast iron is .26 pound, we have $164.75 \times .26$, which gives 42.83 pounds for each valve, or 85.65 pounds for both valves; the total number of cubic inches in both stretcher-rods is 44.46, and as the weight of one cubic inch of wrought iron is .28 pound, $44.446 \times .28$ gives 12.83 pounds total weight for both stretcher-rods. We must now allow some pressure on the valve during exhaust, but on only one valve: the width of port in pressure plate is $2\frac{5}{16}$ inches; length 12 inches; then $2\frac{5}{16} \times 12 = 27.75$ square inches. We will assume at the point of exhaust to have 35 pounds pressure in cylinder; and as the pressure is entrapped in pressure-plate port over valve, we will figure on this pressure; but as we have this pressure for a very small period of time on bottom of valve during commencement of exhaust, the pressure on bottom would lessen constantly until point of compression, when the valve becomes balanced; so to counteract the 35 pounds pressure on top of valve we will allow $\frac{1}{3}$ of 35 pounds as the average pressure on bottom of valve during exhaust point where exhaust commences to end of stroke only, which is 11.6 pounds, and deducting 11.6 pounds from the 35 gives 23.4 pounds pressure on valve; then 27.75 square inches multiplied by 23.4 pounds gives 649.85 pounds pressure on valve. We now have the approximate maximum weight and pull of valves, and adding up we have $85.66 + 12.83 + 649.85 = 748.34$ pounds, and multiplying the above by .15 co-efficient of sliding friction gives 112.25 total pounds pull on both valves. Referring to the unbalanced valve, which is 2,625 pounds, and deducting the above 112.25 from 2,625, gives 2,512.75 pounds more pull for the unbalanced valve. With only 112.25 pounds pull for the balanced valve, we could get the best kind of regulation with a good shaft governor. We will now calculate the horse power absorbed by friction of valve, applying the following formula:

Let H_1 = The horse power absorbed,
" f = the co efficient of friction between the two surfaces,
" V = velocity of valve in feet per minute,
" W = the load or pressure in pounds.

$$H_1 = \frac{f\,W\,V}{33000}$$

Let $f = .15$
" $W = 748.34$
" $V = 85$.

therefore,

$$H_1 = \frac{.15 \times 748.34 \times 85}{33000} = .289$$

horse power required to move valve continuously with 125 pounds steam pressure in steam chest, and at $\frac{1}{3}$ cut-off.

In order to calculate the velocity of valve in feet per minute, we must figure from the number of revolutions, as the engine rotates 170 per minute, and travel of valve 3 inches, we multiply $3 \times 2 = 6$ inches for one revolution, and multiplying $6 \times 170 = 1020$ inches, and reducing to feet, we have $1020 \div 12 = 85$ feet velocity of valve per minute. We will now figure the percentum of power expended in moving valve, applying the following formula:

Let P = percentum of power.
" H_1 = horse power absorbed by valve.
" 100 = constant representing 100 per cent.

$$P = \frac{100 \times H_1}{H}$$

Let $H_1 = .289$.
" $H = 335.58$ H. P. at $\frac{1}{3}$ cut-off.

therefore,

$$P = \frac{100 \times .289}{335.58} = .086$$

percentum of power expended in moving valve.

The writer has used 125 pounds for initial steam pressure for above horse power, on account of having used it in all the previous formulae. As was mentioned in the first article, 80 pounds would be the commercial rating.

The pressure plate has a leaf spring bearing against it; the spring is placed between steam-chest cover and pressure-plate; it is used to keep the pressure-plate in position at all times, and to avoid steam getting between valve and pressure-plate when

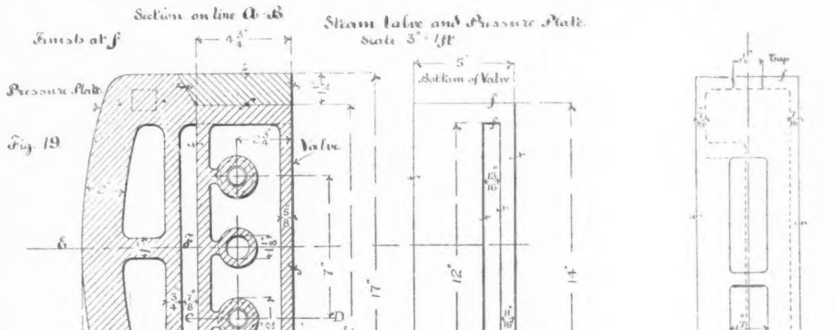


Fig. 19. Fig. 20. Fig. 21. Fig. 22. Fig. 23. Fig. 24.

the throttle is first opened. The diameter of stretcher-rods should be large enough to prevent any tendency to buckle when under compression; $\frac{7}{8}$ inch diameter, if they are made of steel, will be sufficiently large, with only 56.12 pounds push distributed on the two rods.

The lugs *a a*, Fig. 18, are for the purpose of holding the pres-

sure plate from any longitudinal motion; they should be carefully fitted to the inside of steam-chest flanges. The pressure that comes on the pressure-plate also comes on the cylinder directly under the distance pieces; and of course the same pressure per square inch that is on the distance piece is also on the cylinder. The cylinder at this point is made sufficiently strong to resist the pressure of 708.3 pounds per square inch.

EXHAUST VALVES.

Figs. 21, 22, 23 and 24 illustrate the detail of exhaust valves. As the exhaust valves are driven with an independent eccentric, and not connected with steam valve in any way, it does not matter how much pressure is on the valve, with but one exception, and that is wear. So far as the amount of strain on valve-rod and connections are concerned it will do no harm, as the bearings in the connections are all adjustable. The exhaust port in valve should terminate at bottom of valve at an angle of 45° from a vertical center line, as illustrated in Fig. 24 by dotted lines. The valves are arranged this way in order to have a sufficient amount of wearing surface at *n* directly under valve, and also on cylinder bore for valve-seat. By arranging the port as described it will also allow a small amount of wearing surface at *m* on cylinder, and will keep the steam from leaking through into exhaust chest when the live steam is expanding behind piston. As the valve wears down it takes up its own wear; and for the reason of the valve wearing away at bottom, it is necessary to have the slot *h* at right angles to exhaust port; for when the valve is closed, the initial steam entering into cylinder will press directly on top of valve at *k*, and if the slot *h* was at any other angle but the one illustrated the pressure on valve would have a tendency to spring the valve stem. The amount it would spring valve stem would depend to a certain extent on the total amount of wear that had taken place. On a new engine it would not make any difference; but we must of necessity design the valve for after consideration. The valve is cored out back of port to lighten, and the plug *l* is to help support core. The area of port in valve is the same as area in cylinder. We will now figure the pressure on valve seat. The area of exhaust port in cylinder is 21.1 square inches, and multiplying by 125 pounds pressure per square inch gives 2637.5 pounds total pressure; and multiplying 2637.5×.15=395.62 pounds pull at valve seat; but as we have two valves, we will have double the above number of pounds, which gives 791.34 pounds pull for both valves. The above pull, however, will not come directly on eccentric, as there will be a small leverage by reason of the bell-crank lever connected to end of valve stem on exhaust valve, and also intermediate connections from bell crank to wrist-plate. The ratio from eccentric rod back to valve seat will probably be 2¼ to 1. This cannot be exactly determined until we lay out valve motion for both steam and exhaust valves (which will be taken up in a later article); we will, however, calculate the pressure per square inch on valve seat; also the approximate horse power absorbed by both exhaust valves. The amount of wearing surface on valve is 3½ inches on one end, and on the other 4 inches, making a total of 7½ inches; and as the diameter of valve is 5 inches, we multiply 7½×5=37.5 square inches area of wearing surface on ends of valve. The amount of wearing surface between ends and directly under exhaust port in cylinder on valve, is length times diameter of valve, therefore 12×5=60 square inches wearing surface; and adding up gives 37.5+60=97.5 total number of square inches wearing surface. To calculate the number of pounds pressure per square inch on bottom of valve, we must deduct area of exhaust port in cylinder from the above 97.5; then as the area of port is 21.1 square inches, we have 97.5−21.1=76.4 square inches that is under pressure during admission of steam into cylinder, and also at compression. As the total number of pounds pressure on valve is 2637.5 we divide this by 76.4, which gives 34.52 pounds per square inch. During admission of steam the valve is in a very favorable position to receive the above pressure of 34.52 pounds per square inch, and during exhaust the pressure is very small per square inch The above pressure of 34.52 pounds is probably the maximum amount the valve will ever have on it per square inch, but while it is the maximum it is also a minimum amount, and is likely to be much reduced than increased.

Horse power absorbed by valve: As the ratio from valve seat back to eccentric rod is approximately 2¼ to 1, we divide 791.34 by 2¼, which gives 351.7 pounds pull on eccentric rod; and as the travel of eccentric is 141.6 feet per minute, we have, using previous formula, W=351.7 V=141.6, therefore,

$$\frac{351.7\times141.6}{33000}=1.5 \text{ H. P.}$$

expended in moving both valves. The percentum of power would be

$$\frac{100\times1.5}{335.58}=.44$$

per cent. of the total power required to move both exhaust valves, making a total of .526 percentum of horse power required to move both the steam and exhaust valves. In the next article of this series the piston and rod will be taken up, and also cylinder heads.

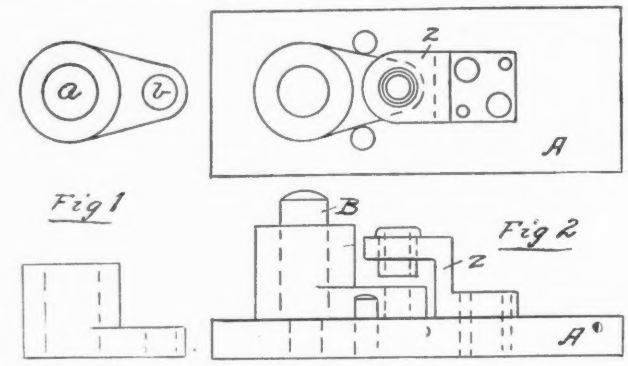
* * *

A FEW SPECIAL TOOLS.

J. T. G.

A friend of mine, whom we will call Freeman, chanced to be out of a job during a dull season, and engaged for work in a cotton machine shop.

The foreman of this shop was a good "hustler," but unfortunately did not appear to be so good a machinist; but this is not one of the unexpected things. After F. was installed in his new quarters he found that his duties consisted in keeping everything in repair, from the elevator to the trip-hammer, to make dies for the latter, to assist the tool-maker in his work, and also to make all jigs and fixtures necessary for a new class of work, which they were just commencing to make. The tool-maker's work was also quite varied: perhaps one day he had a lawn-mower to sharpen, the next the teeth on a reamer to grind. There was no grinding arrangement suitable for reamers in the shop, so the reamers were ground in a lathe by an emery-wheel, on an arbor between



the lathe centers. The shank of the reamer was held in a V groove in a fixture clamped to the tool slide, and the reamer was indexed by a gear fastened to its shank, a pin on the end of a flat spring fitting the teeth on gear, the spring being screwed to the fixture. I do not think this device was patented, as the tool-maker informed F. that it was probably used "before the war." The tool-maker had been trying for some time, without success, to obtain either a grinding machine or a grinding attachment for his lathe.

The shop having bought some new engine lathes, it was necessary to make room for them by removing some old style flat speed lathes. The foreman came to F. to ask his opinion about fitting up one of those worn-out speed lathes for grinding purposes. Upon being asked what he intended to grind, he replied: "Reamers, lawn-mowers, anything you want to grind." A suggestion that it would be better to have a lathe with a V slider, was met by the response that "We could not spare one of the engine lathes: I wish you would rig up one of those speed lathes." Now if Freeman paid no attention to the foreman's orders he would incur his displeasure, and he could not do as ordered and get good results. Of course he could throw up his job, but he thought of a good way of convincing the foreman of his error without injuring his pride. He made a rough sketch of a proposed carriage for this lathe, and brought it to the foreman to have a pattern made. That settled it. F. never heard any more about it, and reamers and lawn-mowers continued to be ground the old way.

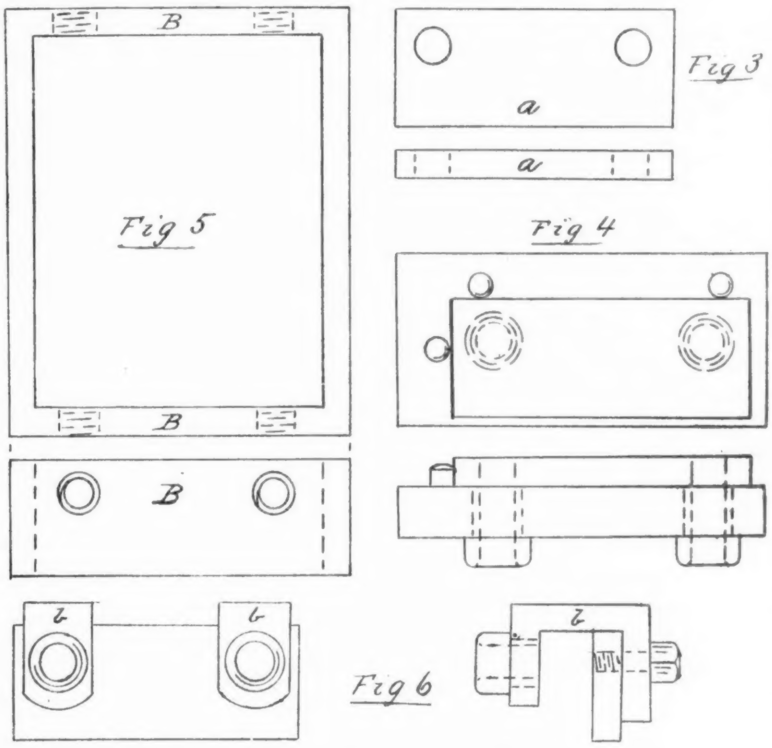
When one of the new machines was ready to be assembled, F. was set to work on it for a while, in order to become familiar with its construction, so as to make the necessary jigs and fixtures for making them in quantities.

A crank (Fig. 1) was keyed to a shaft and operated by a link, to raise and lower a slide. As the limit of variation in the move-

ment of the slide was .01 inch, of course the distance of the holes *a* and *b* from each other must be within .005 inch of the required distance. F. called the foreman's attention to this, who promised to have a casting made for a jig for this purpose.

In the meantime the castings for the cranks came along, and the foreman had them drilled by a workman who usually ran a drill press, with the result that most of them were spoiled, as there was scarcely two of them alike.

When the foreman's attention was called to this he said that he told the workman to make them "just right," and "if a man couldn't do a better job than *that*, he didn't want such men around." He was reminded of his promise to have a casting made for a jig, and also informed that the job was too exact to be laid out and drilled in a drill press without a fixture for the purpose. F. was then ordered to make a fixture as soon as possi-



ble. So he found a cast iron plate as at A, Fig. 2, which he planed on two sides and drilled. He then turned up and drove in a stud *b* with the body the size of hole *a*, Fig. 1. He then drilled pin-holes and drove in two pins, as shown, to keep the crank in position on plate. He then had a forging made **Z** shaped, as shown in Fig. 2, which he drilled for a bushing, to guide the drill. He then drilled and doweled the forging to plate A, Fig. 2.

This worked satisfactorily. The crank is shown in position on jig. The hole *a* in crank was first drilled in the lathe, and then the crank was placed on jig and hole *b* drilled.

If absolute accuracy had been required it would have been better to have clamped the plate with stud and crank in it on the face-plate of a lathe, then drill and tap a small hole about where hole *b* should come, then turn up a collar of some known size, screw collar to crank and set the right distance from stud by calipers. Then true up collar by an outside indicator, remove collar and screw, and drill hole *b* with boring tool, then after the first crank was drilled the rig would be set for the rest. It is obvious that this last operation would take longer than to drill by jig in a drill press. It is a good plan for a machinist to know the amount of error permissible in his work, as sometimes the difference between what is good enough for the purpose and what is just right, although it may be small, might make quite a difference in the time book.

At another time F. had a 3/8 square key handed to him with an order to make a die, to reduce a number of them to one thickness, without either filing or milling.

F. made a sketch of what we will call an inside broach, to be made in two halves and clamped together; he intended to force the keys through on an arbor press. This sketch was shown to the foreman, who said he "Didn't want any such thing;" what he wanted was to "make a square hole in a steel block tapering at one end so as to drive through with a hammer." As the key stock came 1/32 inch too large, it was plain to F. that this wouldn't work. So he consulted the tool-maker, who suggested forging them down cold under the trip-hammer. This suggestion was adopted with the consent of the foreman, and a pair of steel dies made, one with a plain face and the other had a groove cut in it to the depth required and about twice the width of the key. These dies were secured to cast iron blocks by taper keys. This worked very nicely, but made the keys a little wider than before.

One of the workmen in the shop asked F.'s opinion as to whether a jig could be made to drill and tap some of his work that caused a good deal of unnecessary fitting. Upon looking it up F. gave the opinion that one could be made for the purpose The workman requested F. to suggest this to the foreman. F. did so. The foreman replied that it cost too much to make such expensive tools.

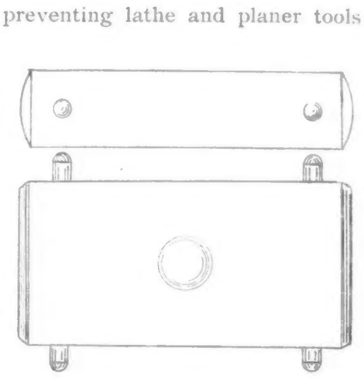
Almost any machinist of experience can probably recall similar cases to this. Here was a job which the shop did year in and out, and would not make a jig for the purpose on the ground of economy. I think it is poor economy to have men work without the necessary tools and fixtures, and also having them in good condition for the work in hand. F. told the workman what the foreman said. So the workman made a temporary rig for himself, and hid it under the bench. One day the foreman came across it and decided to have a permanent fixture made; so he gave F. an order to make one as cheap as possible.

The parts which the jigs were to be made for consisted of two plates, like *a*, Fig. 3, to be drilled the required distance from the top and edges, to match two tapped holes in inside edges of the frame B, Fig. 5. F. went into the blacksmith shop and obtained an iron plate about 1/2 inch thick, a little wider and longer than the plate to be drilled. This he drilled with holes the required distance apart and drove in bushings. He then drilled three pin-holes and drove in pins, as shown in Fig. 4, the pins being the required distance from bushings. In Fig. 4 the plate is shown in position on jig. It was intended to be held to it by clamps. The frame B, Fig. 5, had but four sides, as the mechanism was suspended by hooks upon cross-bars through the plates *a*, Fig. 3, the holes for the cross-bars not being shown. To make a jig for drilling this F. procured an iron plate, and made it to the right length, Fig. 6. He then had two pieces forged, as shown at *b b*, Fig. 6, and drilled and screwed them to the plate. He then laid out the centers of holes for bushings by surface gage, and made two bushings, one for the drill and the other for the tap. The jig was intended to be clamped to the frame also. The holes being the same distance from each end of jig, it could be reversed for opposite edges of frame.

* * *

TOOL POST BLOCK.

A handy little device for preventing lathe and planer tools from being bruised and bent by the clamping screw, is used by Gould & Eberhardt in their own work and on tools made by them. This was originated to save the tool holders, which they use extensively, from the destruction of the "bending press" action common to all ordinary tool posts, and does this to perfection. They are of steel, tempered to a "blue" or spring temper, and held in place endwise by the pins shown, being free to move vertically in the tool-post block.



* * *

THE man who doesn't know why he used a certain change gear for cutting a certain thread, is helpless if the "table of gears" gets lost or mislaid.

LAYING files down on a dirty bench does not improve their capacity for work. The grease and dirt clog the teeth and interfere with their proper cutting.

Entered at the Post Office in New York City as Second-class Mail Matter.

MACHINERY,

A practical journal for Machinists and Engineers and for all who are interested in Machinery.

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Associate Editors.

F. W. Jopling, - - - - - - - - Art Editor.

THE editorial and news colums of this journal are not for sale, and under no circumstances will any matter be inserted therein for pay, or in consideration of advertising, or on account of the purchase of cop'es of the paper.

WE solicit communications from practical men on subjects pertaining to Machinery, for which the necessary illustrations will be made at our expense.

ALL copy must reach us by the 10th of the month preceding publication.

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will be paid on January 1st, 1896, to the forty-eight persons who send us the forty-eight largest clubs to MACHINERY before the above date, as follows:

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JANUARY, 1895.

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Every issue of MACHINERY during the coming year will exceed 10,000 copies.

Three hundred and seventy-nine subscriptions for MACHINERY were received in one day last week, and we haven't really got to work yet.

SUCCESS.

When the publication of MACHINERY was undertaken five months ago, due allowance was made for the business conditions then existing, and a long and up-hill struggle was provided for. So many expressions of good-will and encouragement have come from those who are strangers to us, that it may gratify the numerous friends we seem to have throughout the country to know that the success of MACHINERY is practically assured. The new business (subscriptions and advertising) for each one of the last three months has exceeded the actual running expenses of that month, and as there is no reason to expect that this proportion will change with the improved business conditions which every one looks for in 1895, we feel that with the abundant means at our command the future of the paper is assured.

We do not know of any trade journal that has made a better record than this; and the result justifies our belief that a field existed for a cheap mechanical paper.

* * *

THE chances for improving your shop methods are probably greater than you imagine, and the best way of discovering this is to note carefully what other mechanics are doing, and very often you can adopt methods that are used on other classes of work, with slight modification.

* * *

THE DRAWING-ROOM AND THE SHOP.

There is very often considerable unnecessary friction between these departments, and it is usually traceable to the fact that the proper functions of each department are not correctly understood. Too many look upon the drawing room as a luxury, made expressly for a few dudes who had rather draw than get their hands dirty, and on the other hand some draughtsmen seem to consider all shop men as mere tools who are of little account except to do as they are told. These feelings are not apt to breed harmony, and as a result the two departments are in constant discord.

It is absolutely necessary, however, to consider the drawing room as the fountain of information for the shop, and whether the information given is correct or not is the business of the drawing room. Making the drawing room the head does not imply superiority, but as this is the department which designs, draws and plans all new work (very often with the help of the shop to be sure) and which keeps a record of all work done, it is natural and right that all information for work should come from here.

The drawings should contain all necessary information for the workman who is to make the article shown, and right here it is well to remark that the best draughtsmen are generally those who have had shop practice and know just what the workman needs in this respect. Have some system about the drawings, and have certain signs represent certain processes of work, instead of covering the drawing with a whole mess of writing telling the workmen what should be made plain by the drawing itself.

Have it understood thoroughly that scaling a drawing for dimensions will not be tolerated, but that all necessary dimensions must be on the drawings in plain figures. This throws the responsibility on the drawing-room, where it belongs, and all drawings should be thoroughly checked by the chief draughtsman or his assistant before going into the shop, for mistakes are costly and also make the men lose confidence in the drawings.

Have it understood that whenever a man finds a dimension which seems wrong to him, he should call his foreman's attention to it, but should not scale the drawing or take any verbal instructions in the matter. The drawing must be altered if it is wrong and the blame fall on the drawing room. Above all things absolutely prohibit any

drawing being altered in the least except by the drawing room, as in instances to the writer's knowledge dimensions have been altered without the knowledge of the drawing room, and consequent confusion has ensued. It is an open question many times as to how far the drawing room should go in directing shop work, and usually this must be determined by the work in question. Take for example the case of a large foundation plate; some of the holes are for the foundation bolts, and others to be drilled. The question is, shall the drawing designate whether the hole be drilled or cored, or merely give the dimension and let the shop do whatever it can do best.

A better way would seem to be to select some sign which can be placed near the hole which shall mean that the hole need not be exact in size but be correct within a predetermined limit. It is usually money in pocket to consult with the head of the shop, department or section in which the work in hand is to be done, with regard to the best way of making the article, for very often a slight change in design, or in the method of construction will affect the cost to a great extent, and this being directly in the shopman's line gives him a chance to exercise his ability which is usually of a practical nature and will assist in the work. And he will work with more interest when he is called in consultation and made to feel that the drawing room and shop are not so far apart after all.

There is more truth than poetry in the saying that a "draughtsman never has a clear conscience," and is always dreading some mistake causing delay and expense in the work, and any one who has been in the draughtsman's position knows this too well. This may perhaps be the shopman's recompense for not being able to keep his hands clean at his work, for he is pretty sure to be free from this anxiety, which is not imaginary but a stern reality. Each department has its important part to fill, and each is dependent on the other to a great extent. What the draughtsman escapes in manual labor he pays for in mental exertion and anxiety; and harmony between these departments is an absolute necessity if economic production is desired.

* * *

Give each man a place to keep his tools and special appliances that he uses, such as are not kept in the tool room, and he will keep them in better condition and take more interest in his work. A roomy drawer or cupboard is a good place to keep these and should be provided where possible, also room for a dinner basket, hat and coats. These conveniences are appreciated.

* * *

In oiling as in firing—little and often gives the best results.

MODERN SHOP METHODS.

Fred H. Colvin.

One of the most characteristic shops it has ever been my pleasure to visit is that of the Pedrick and Ayer Co., of Philadelphia, of which Mr. Daniel S. Pedrick is Superintendent, assisted by his two sons, one in the office and one in the shop.

From the time we enter the shop until we leave, we see imprints of Mr. Pedrick's mechanical ideas, which go a long way in making this a distinctively modern shop. With the exception of the lathes, almost the entire shop equipment is practically the production of their own shop, and while this is not always an advantage, this case seems to be an exception to the general rule of shops which insist that everything shall be of tİheir own make.

The shop itself is a four story building with the upper floors arranged on the gallery plan, which distributes the light to good advantage, although it takes considerable room out of the upper floor space; but where light can only be had front and back, as in city blocks, this plan is very desirable.

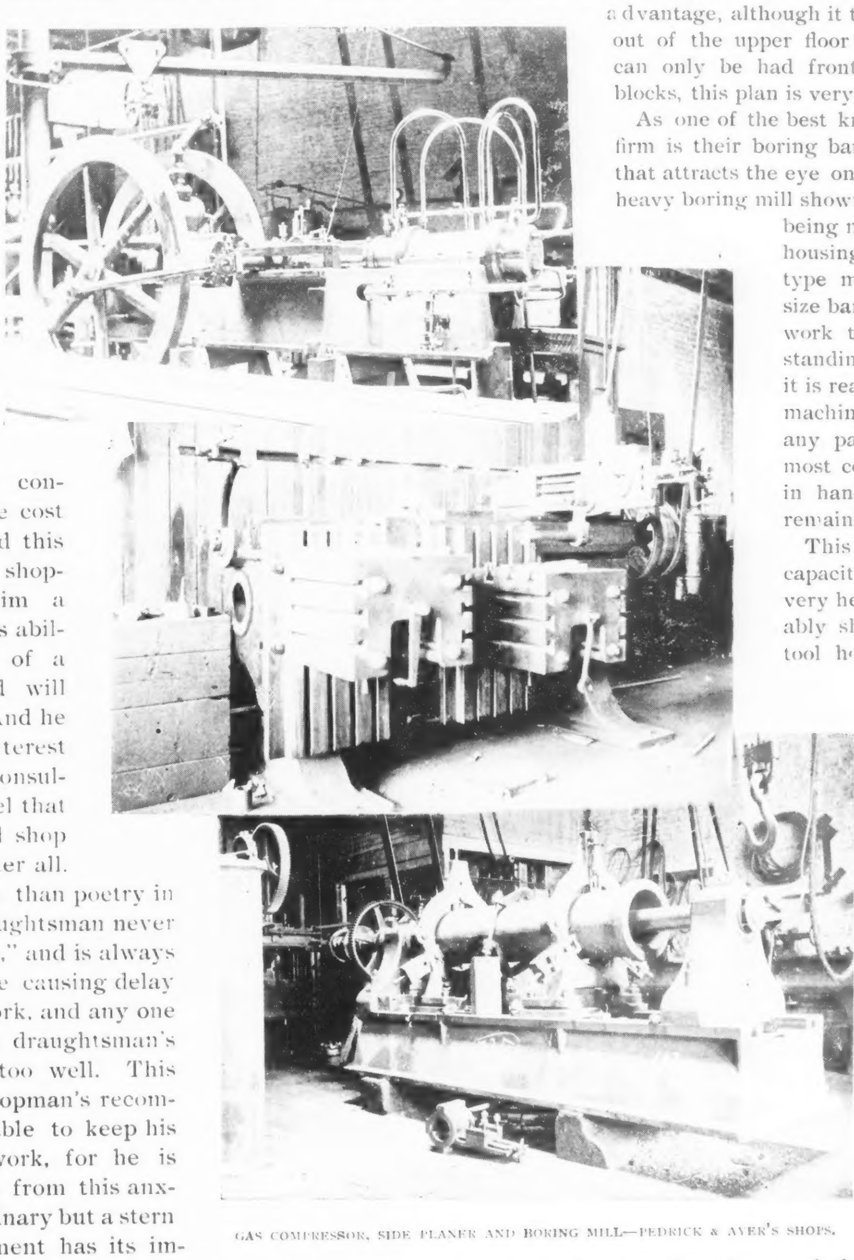
As one of the best known specialties of this firm is their boring bars, one of the first tools that attracts the eye on the ground floor is the heavy boring mill shown in the engraving; this being merely a heavy bed with housings for boring bars of the type made by this firm, the size bar used depending on the work to be done. Notwithstanding its heavy appearance it is really a heavy "portable" machine, and can be moved to any part of the floor that is most convenient for the work in hand, though as a rule it remains where it is.

This machine has a large capacity and turns out some very heavy work in a remarkably short time. The facing tool holder is shown on the floor in front of the machine, not being used on the piece now being bored.

The Richards side-planer shown in this group is well known for its capacity on a large variety of work, for instead of fastening the work to the planer and carrying it under the tool, the work is simply fastened in place as near the machine as possible, or as the work demands, and it goes to work. As an instance of its large capacity, there were a lot of heavy steel plates to be planed on the edges, and they were far too wide for any planer in the vicinity, so an opening was made in the floor beside the planer, the plates fastened up to the planer, edges up, and the job was done in short order. For special work of this kind, such as any jobbing shop must expect to handle at any time, these tools are very useful, but as with many other good tools, they have a special field in which they excel.

The remaining picture of this group is a Pintsch gas compressor built by Pedrick & Ayer Co. during the recent dull times in their regular line of work, and it speaks volumes for the capacity and management of the shop to be able to take hold of a new and entirely different kind of work, in competition with shops in that line of business.

The lower picture of the next group shows a heavy milling machine at work, and while there is little out of the usual in the machine, unless it is its very generous proportions and its con-



Gas Compressor, Side Planer and Boring Mill—Pedrick & Ayer's Shops.

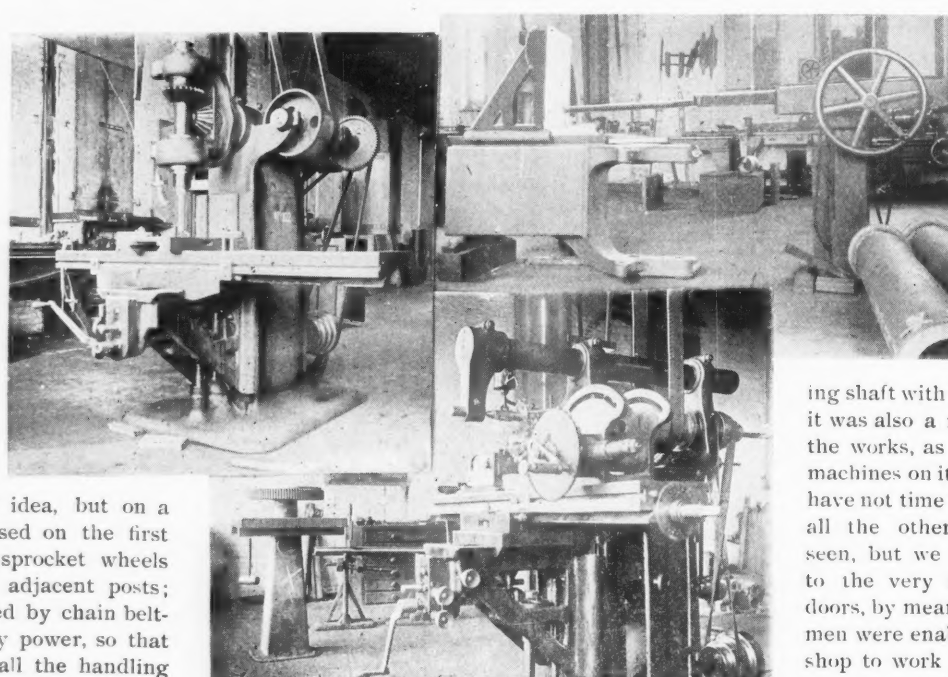
venience, the methods used in making the machine has some good points.

Jigs are usually supposed to be confined to small work, and this is too often the case, but we have an exception here, for the whole frame of this machine, after having the vertical face planed, goes into a jig, and, being leveled by this face, the holes for the spindle and for the supporting arm are bored by special bars, which drop into bearings set the right distance apart and in the right position, bringing them accurately in line, and doing it very quickly, besides avoiding the expensive "fitting," which is so often necessary where some similar arrangement is not used.

It was impossible to get a satisfactory photograph of this, but the idea will be plain to every mechanic, and may form a basis for further developments in the jig line Attention is called to the small bench or table in this view, which is simply a cast standard with a heavy wooden top fastened to it, and the convenience of being able to get all around your work at the bench is well worth the cost of these benches, several of which are scat tered around the shop.

The right hand figure shows a labor and money saving device, which is located near the jig just mentioned, and is used in fitting the knee of the machine to the vertical surface or "way" on which it travels, as these fits must be good to have the machine durable and accurate. The knee is moved back and forth on the way by the rack and pinion shown, connection being made by simple universal joint, so as to avoid cramping.

This makes the workman independent of any outside help and avoids much lost time waiting for a helper to move the knee in order to see the bearing surfaces. A similar idea, but on a larger scale, is used on the first floor, where two sprocket wheels are mounted on adjacent posts; these are connected by chain belting and driven by power, so that one man can do all the handling of the heavy work without assistance.



A GROUP OF HEAVY TOOLS, PEDRICK & AYER'S SHOPS.

The vertical milling machine shown possesses several good points, as it is adjustable to any angle, has ample driving power for any work that will be put on it and is heavy enough to avoid springing, which means accurate work and more of it. This is used for heavy surfacing work, for milling the dovetailed sliding surfaces used in adjusting planer tool posts and similar work, being capable of using large mills and taking heavy cuts, which must ultimately be the future of milling, instead of "nibbling" away, as is too often done at present. This is now at work on boring a plate with the single point tool shown, work far within its capacity.

Air hoists serve all the heavy tools of the shop and are supplied by a new air pump made by this firm, which takes care of itself, runs when air is needed and stops when the pressure is sufficient, only requiring a little oil to keep it good natured and ready for work. Mr. Pedrick contemplates in the near future an air pipe-line system, with soldered joints, to supply every section of the shop, and believes that the air saved over the present joints will warrant the extra expense. Some of the many interesting shop details, which will give valuable hints to other shops, must be reserved for another article.

* * *

It is a well-proven fact that an axle or shaft runs better and requires less lubricant if run in one direction only. The fibres become smoothed down in the direction of running and reversing this turns them against the grain.

NOTES ON MODERN METHODS.

Slow Pay.

During a visit by the writer to the works of the Keep It Dark Mfg. Co., of Darkville, several points of interest were seen, some of them double. A boy was noticed drilling holes in a piece of cast iron, and we found that the drill was of the well known twisted form, with two lips or cutting teeth (the boy had got over cutting his teeth), and that this drill was caused to revolve in a special machine, designed for drilling holes, called, in this thoroughly up-to-date establishment, a "drill press." The drill was 'steen-ninths of an inch in diameter, and made several revolutions during the working day, and was fed into its work by the boy, who turned a wheel, this wheel being connected with some ingenious mechanism specially designed for the purpose for which it was designed to accomplish. The result of this was highly interesting to the writer, and was more so, in every respect, to the others, who informed him that they had never seen anything quite like some of the things mentioned until they looked at them one day when—but we digress. To return to our subject, we found the feed of this drill to be a fraction of an inch to 19 revolutions, so that each cutting edge or lip had a chip, thousandths of an inch in thickness, to cut; this being a great surprise to me, and also to some others, who said they had never heard of anything of the sort before, and the Keep It Dark Co. are entitled to great credit for allowing these things to be published to an admiring world, than whom no more than this could be much wished for. A revolving shaft with pulleys and things on it was also a noticeable feature of the works, as well as a floor with machines on it. I am sorry that I have not time and space to mention all the other interesting things seen, but we might call attention to the very complete system of doors, by means of which the workmen were enabled to come into the shop to work in the morning and go out at night, after the day's labor was done, or labor's day was done. We also noticed a hose house in the yard*, which was alleged to contain a hose-wagon and and some fire-hose; but on account of the rush of business and lack of room, there were piled up in front of the hose-house door several tons of pig iron, which might be useful for some things more than others, and probably is. We hope to be able to give more of these notes (which are the only kind the bank will look at for the writer) in the (very remote) future.

CALEB CLARK WALWORTH.

Mr. Caleb Clark Walworth died on the 22d of November, and New England loses one of her best known mechanics in the line of pipe and iron specialties. Born in New Hampshire, he finally located in Boston, after being burnt out by the Chicago fire, and as head of the Walworth Mfg. Co. has made his ingenuity and business management well known to the trade. Various machines for drilling, tapping and threading, vises, wrenches, radiators, steam traps, and poles for electric railways, are among the many products of his inventiveness, and he is credited with being the first in America to adopt a standard for valves and pipe fittings.

* * *

Don't let the planer "run over" any further than necessary, as all the time so lost cannot be made up.

* This yard was out doors.

FOR THE DESIGNERS' NOTE BOOK.

H. M. Norris.

A rolling stone gathers no moss but a young man who stays too long in one place will gather more moss than brains.

The experience of working one year in each of five shops, manufacturing a similar line of work, is far more valuable to a man than that gained through working five years in one shop.

A sharp pencil and ready note-book are the best mediums for collecting and retaining knowledge for use in after years.

In designing a machine which is to be built in several sizes, much time and labor can be saved by first determining the principal dimensions of the largest and smallest sizes, and then increasing or decreasing the dimensions of the relative parts of the intermediate machines in arithmetical progression from the smallest to the largest, and *vice versa.*

For example: Let us consider that we are designing a tool grinder in four sizes, the smallest of which is to carry an 18 inch wheel, the next a 24 inch, the next a 30 inch, and the largest a 36 inch. If 2¼ inch is a suitable diameter of spindle for the smallest wheel, and 3 inch for the largest, then 3−2¼ divided by the number of machines less 1 is the common difference between the relative sizes. Hence each spindle should be

$$\frac{3-2.25}{4-1}=.25 \text{ inches}$$

larger in diameter than the next smaller one, which would make them 2¼ inch, 2½ inch, 2¾ inch and 3 inch respectively.

Another plan was recommended to the writer by Dr. Coleman Sellers, while he had the pleasure of being in his employ—to take the difference between the nominal sizes of machines, that is of the largest and smallest machines, and the difference between the corresponding dimensions of the parts required. Divide the latter by the former, and the result attained will be a factor which, multiplied by the nominal capacity or nominal size of the machine and increased or diminished by a constant increment will give the size of part required. The increment is found by multiplying the nominal capacity for some known size by the factor obtained, and subtracting the result from the size of the part required.

Making $\triangle$ = the nominal capacity of the machine under consideration.

$$f=\frac{\text{difference between largest and smallest parts}}{\text{difference between sizes of corresponding machines.}}$$

c = required dimension of one of the known parts − f ($\triangle$ of the corresponding machine).

The formula then becomes:

$$\triangle \times f+c=x$$

Example: If a certain shaft on a 72 inch planer is 3 inches in diameter, and on a 42 inch planer 1⅞ inch in diameter, what should be its diameter on a 60 inch planer?

$\triangle=60.$

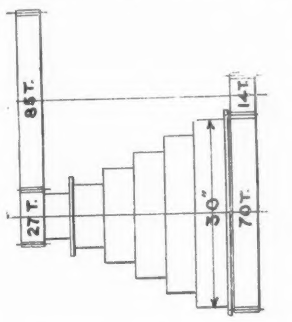
$$f=\frac{3-1\frac{7}{8}}{72-42}=.0375.$$

$c=3-.0375\times 72=.3.$

$60\times .0375+.3=2.55$ or $2\frac{9}{16}$ nearly.

Likewise: The diameter of shaft for any size planer can be determined by multiplying the $\triangle$ by the same factor (f) and increasing by the same increment (c). Thus: $48\times .0375+.3=$ the diameter of shaft for a 48 inch planer, and $84\times .0375+.3=$ the diameter of shaft for an 84 inch planer.

In designing a cone for a back-geared machine it is a good plan to determine the diameter of the largest step first and then to make the diameter of the small step such that when the belt is shifted from the smallest step with the back gears out of mesh to each successive larger step, and then back again to the smallest step with the back gears in mesh, the speed of the machine will be decreased in arithmetical progression. If the diameter of the largest step and the ratio of the back gears are given, the diameter of the small step can be readily determined by the formula



$$d^2=\frac{D^2}{R^{\frac{s}{s-1}}}$$

where d = diameter of smallest step, D = diameter of largest step, R = ratio of back gears, and s = number of steps on the cone.

Example: If the largest diameter of a five-step cone is 30 inches, and its speed is transmitted through gears of 27, 85, 14 and 70 teeth respectively, as per sketch, what should be the diameter of the small step?

$$\text{By substitution } d^2=\frac{30^2}{(15.74)^{\frac{5}{5-1}}}=99.23$$

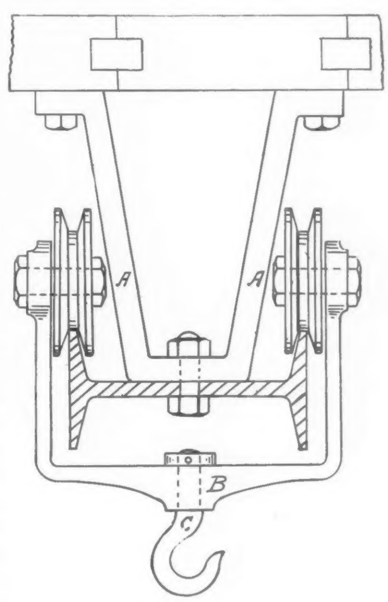
$$\therefore d=\sqrt{99.23}=9.96 \text{ inches.}$$

Although it is undoubtedly best to make a counter-shaft cone larger in diameter than the cone it drives on the machine, as when they are of equal diameter the belt has a greater tendency to slip on the counter-shaft cone, it is always advisable to so design a cone that it will work as well with one having the relative steps equal, so that both cones may be cast from the same pattern.

* * *

A HOME-MADE TRAVELLING CRANE.

The appropriations being nearly exhausted in the case of a small lighting plant, and a travelling crane being almost a necessity for handling the armatures, etc., of the generators, the engineer in charge sketched the plan shown below and had it made in the repair shop. The frame A A is simply to hold the I beam which forms the track in place, and one is supplied at as frequent intervals as strength demands. The upper edges of the I beam forms the track, and the rollers are cast iron, governed as shown, and are held in the yoke B by the studs shown. These are fastened solidly in the yoke and form the shaft or axle for the rollers. A swivel crane hook C completes the equipment and makes a very handy addition to almost any shop or lighting plant. The cost is very little, and should not deter any one from making it who has use for one.



* * *

A simple formula for finding the horse power a steel shaft will transmit is

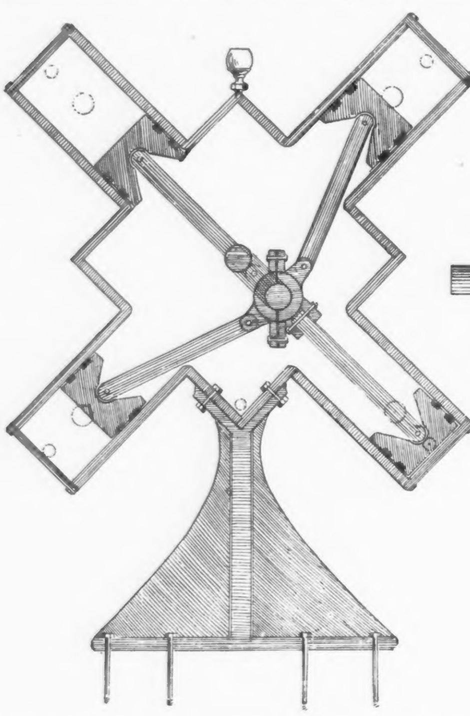
$$\frac{D^3\times N}{100}$$

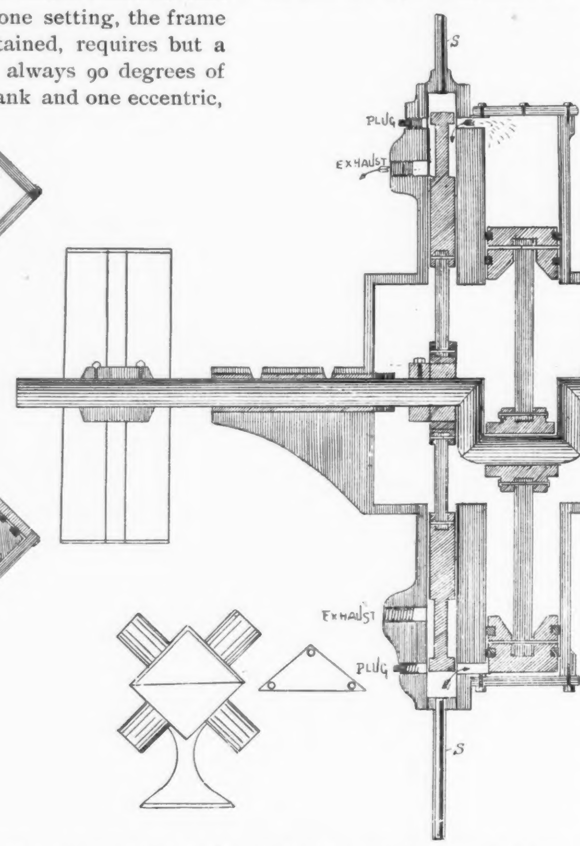
which is nearly correct, and is based on the fact that a 1-inch shaft running 100 turns a minute will usually transmit 1 H. P. In other words, cube the diameter in inches (multiply twice by itself) and multiply by revolutions per minute, dividing the product by 100 for the H. P. A 2-inch shaft running 150 revolutions per minute will then transmit

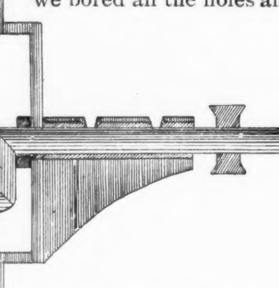
$$\frac{2\times 2\times 2\times 150}{100}\ 12 \text{ H. P.}$$

AMERICAN CYCLONE ENGINE.

The accompanying cut represents the patent four cylinder engine of D. E. Crosby, named the American Cyclone. It has several advantages over other engines for special classes of work. A small compact frame, with cylinders and steam chests all cast in one piece, each pair can be bored with one setting, the frame being small and box-shaped and self-contained, requires but a small amount of metal. No dead point: always 90 degrees of pressure on the crank-pin, and only one crank and one eccentric,







with positive balance valves, and no stuffing-box of any kind, and capable of running from fifty to fifteen hundred per minute; will run in any position, floor, wall or ceiling, and may be coupled direct to shafting, saw mandrel or drill spindle, and for running fans, dynamos for head and search lights for locomotives, pumps and fire engines, also for road and agricultural purposes, has few equals. When crank is at dead center, in respect to one pair of pistons, it is at point of greatest leverage in respect to the other pair; the valve rods are all worked by one eccentric, and all connecting rods work the same crank; it has passed the experimental stage and can now be guaranteed a success. For saw mills and factories each department can be run separate, and no loss from running a large amount of belting and shafting that are not needed. The lower half of the box frame outside ends is cast with the box, which makes the lower part oil tight, and triangular doors are put in to enclose the top.

For particulars address D. E. Crosby, 936 North 10th street, Philadelphia, Pa.

* * *

IN A SMALL SHOP.

Caleb Topham.

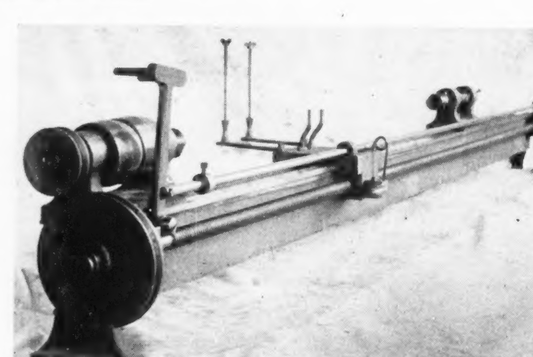
We are a small concern who make a special kind of tools, and as we rarely make more than one machine of a kind, we have not adopted Mr. Snow's suggestions for a drawing-room, because we know it would be expensive and useless in our case. We draw to a convenient scale on heavy manilla paper, ink it in and varnish it, then bind the edges with a heavy cloth binding-tape that comes already gummed, and fastens both sides of the sheet. This goes into the shop, the machine is built from it and we file it way, although nine chances to one we will never build another like it. We have two weak points, however, which might be improved, and which will be as we progress; and they are, non-uniformity in sizes of sheets and undimensioned drawings. Of course when we build several machines from the same design we make tracings and blue prints, and they are dimensioned, but while it makes little difference in building one machine, dimensions are good things to have on a drawing. However, the expense of an elaborate system like Mr. Snow's would be absurd for our place, as the shop is small. The varnished drawings do nicely in our case, and the lack of duplicates for record in case of fire is not so great as in a shop doing regular work. A sample index book, giving the numbers of the drawings, who they were for, and the date is all that is required.

We recently moved part of our machinery to another room, to make room for an enlargement of the pattern department, and one of our boys suggested a little plan that may be useful to others. Before putting up the stringers for countershafts in the new room, we decided just where to put each lathe, planer, etc., and measured the distance between holes in counters before taking them down. Then laying out these distances on the stringers (still on the floor), we bored all the holes and then put them up, for it is a good deal easier to bore *down* and let the chips go on the floor, than to stand on a shaky stepladder and bore *up*, getting the chips in your eyes and mouth. Then, taking down the counters from the old room, we immediately put them up in place, saving time, labor and annoyance. This is a good scheme, and will work in a good many places.

* * *

SILK WINDING MACHINE.

This is a special machine for manufacturers of casket hardware, for winding floss silk on casket handle bars. The machine is half automatic, so that the bar being placed between the centers, and the machine being started, it begins to wind without any further manipulation, the nut on the carriage being automatically thrown into engagement with the screw by means of the spring shown at the front.



It will be seen that the machine is started by moving the rod which extends the whole length of the bed, so that no matter what length of bar is being wound, the machine may be started immediately after the bar is placed in the centers, and the stop collar on the rod being set at any desired point, the machine will stop when the carriage reaches that point. The screw feed is driven by differential gearing on the inside of the larger V groove pulley shown, and is made a nominal feed of 112 to 1 inch, which may be varied enough to suit the requirements of different users by making the smaller V goove pulley a little larger or smaller diameter as wanted.

The machine will wind anything from the smallest child's bar to a 6 foot extension bar.

For further information address the Meriden Machine Tool Co., Meriden, Conn.

THE SLIDE RULE IN THE SHOP.—(3.)

WILLIAM COX.

PRACTICAL EXAMPLES.

1. *To find the area of a ring.*

Area=0.7854 (D^2-d^2), for which we have, leaving readers to work out the mathematical demonstration,

C...	Set sum of diameters	Find area
D...	To G. P.* 1.273	Over difference of diameters.

2. *Levers.*

The slide rule is specially adapted to the solution of problems connected with levers, the general formula for which may be stated thus:

Long arm × power applied = short arm × power transmitted.

For the slide rule this is diagrammatically shown by

C...	Set long arm	Find power transmitted
D...	To short arm	Over power applied.

When any three terms are therefore known, the fourth is at once obtained. It is immaterial, of course, whether it be power applied or a weight, in the latter case the result obtained is weight transmitted or raised.

3. *Diameter of pulleys or teeth of gears.*

The relation of the diameters of two pulleys, or the number of teeth of two gears, to the number of revolutions they respectively make, is precisely the same as the arms and power in the case of levers, so that we have

C...	Set diameter or teeth of driving	Find revolutions of driven
D..	To diameter or teeth of driven	Above revolutions of driving.

4. *Diameter and pitch of gears.*

$$\text{Number of teeth} = \frac{\text{diam} \times 3.1416}{\text{pitch of teeth.}} = \frac{\text{circumference}}{\text{pitch.}}$$

C...	Set pitch	Under diameter
D..	To 3.1416	Find number of teeth.

In this example the diameter is taken on the pitch line, while the pitch is the circular one measured along the curve of the pitch line, and not what is termed by Haswell the true or chordial pitch measured by a straight line from tooth to tooth. Of course the diameter is obtained by the same setting, by taking the number of teeth on the rule and the corresponding diameter on the slide. When the diametral pitch is given, and it is required to know the circular pitch, then we have

C...	Set diametral pitch	Under 1 or index
D..	To 3.1416	Find circular pitch.

5. *To find the diameter of a pulley in inches and the number of revolutions per minute it must make to produce a given required belt speed in feet per minute.*

Belt speed × 3.82 = diameter × revolutions.

C...	Set belt speed	Find revolutions
D..	To any diameter.	Above 3.82.

There is, however, a much more satisfactory solution of this problem, which requires the slide to be taken out of the rule, turned around end for end and reinserted in the rule, so that scale B inverted of the slide (designated B. I.) is contiguous to scale D of the rule, and scale C inverted (likewise designated C. I.) is contiguous to scale A of the rule. As scales C and D do not lie alongside of each other, it is necessary to use the runner for every operation of setting the slide to the rule and to read the results. This method has, however, in some cases very great advantages, as in the case of the above example, for which we have

C. I..	Set belt speed	Under any diameter
D....	3.82	Find revolutions.

What diameter of pulley and what number of revolutions per minute will give a belt speed of 4,000 feet per minute?

C. I..	Set 4,000	Under 16 inches	Under 18 in.	Under 20 in.
D....	To 3.82	Find 955 revolutions.	Find 849	Find 764

and so on with the same setting for any other diameter: all coinciding lines on the slide and on the rule being diameters and their corresponding revolutions, any one or all of which combinations give the same belt speed of 4,000 feet per minute, from which selection can be at once made of the most suitable one. If the belt speed is given in feet per second, use the gauge point 229 in place of 3.82. I leave to readers of MACHINERY to puzzle out and find the why and wherefore of this problem, which has, I believe never been given to the public before, and which will sometimes be found very useful.

* G. P. stands for "Gauge Point," which is a fixed constant used in the solution of certain formulæ, just as 3.416 is the gauge point having reference to the diameters and circumferences of circles.

6. *To find the diameters of two gears to work at given velocities, the distance between centers of shafts and the speed of the driving shaft being known.*

C...	Set distance between centers	Find diameter of gears
D..	To half sum of their revolutions	Above revolutions of each gear.

A shaft making 60 revolutioms per minute is required to drive another one at 100 revolutions; the distance between their centers is 60 inches; what must be the diameter of each gear?

C...	Set 60 inches	Find 45 inches	Find 75 inches
D..	To 80 $\left\{\frac{60+100}{2}\right\}$	Above 60 revolutions	Above 100 revolutions.

The two gears must therefore be 45 and 75 inches respectively, the sum of their respective radii being also 60 inches, the same as the distance between centers of shafts.

7. *Leather belting.*

The following formulæ are often used for good oak tanned leather belting:

$$\text{Width in inches} = \frac{600 \text{ H. P.}}{\text{velocity.}} \text{ for single belts;}$$

$$\text{Width in inches} = \frac{375 \text{ H. P.}}{\text{velocity.}} \text{ for double belts,}$$

the velocity being the belt speed in feet per minute. For the slide rule

C..	Set G. P. 600	Find width of single belt
D..	To velocity	Above actual horse power to be transmitted.

For double belts use gauge point 375 instead of 600. Of course those who think these constants are too high or too low may use any others in their place, the method of procedure being exactly the same.

8. *To find the change wheels for a screw cutting lathe.*

Let T=number of threads per inch in lead screw;
N=number of threads per inch to be cut;
S=teeth in lead screw gear;
L=teeth in spindle gear;
W=teeth in stud wheel (driven) } compound gearing;
P=teeth in stud pinion (driver) }

then for a straight geared lathe,

$$S = \frac{N \times L}{T} \text{ or } L = \frac{N \times S}{T}$$

and for a compound geared lathe,

$$S = \frac{N \times L \times P}{T \times W} \text{ or } W = \frac{N \times L \times P}{T \times S}$$

which for the slide rule gives

C...	Set T	Under L	Find L
D..	To N	Find S	or over S.

thus giving at a glance a variety of combinations of gears for the screw and the spindle, from which a suitable one can be at once chosen.

For compound gear we have

C...	Set T	R to P	W to R	Under L
D..	To N			Find S

and

C...	Set T	R to P	S to R	Under L
D..	To N			Find W.

In the above R signifies the brass runner of the slide rule, so that the second operation means, slide the runner to the graduation answering to the value of P; and the third operation, bring the graduation answering to the value of W or S to the runner.

9. *Weight per foot of square, round and flat wrought iron bars.*

ROUND BARS.

C...	Set G. P. 0.382	Below diameter in inches
D..	To diameter in inches	Find weight in pounds.

SQUARE AND FLAT BARS.

C...	Set G. P. 0.3	Below other side in inches
D..	To one side in inches.	Find weight in pounds.

It will be evident that for square bars the *one* side and the *other* side are both the same figure. The above gauge points 0.382 and 0.3 are only to be used when the dimensions of the bars are in inches and tenths of an inch. When they are given in eighths of an inch, the following must be used.

ROUND BARS.

C...	Set G. P. 24.4	Below diameter in eighths
D..	To diameter in eighths	Find weight in pounds.

Square and flat bars.

C...	Set G. P. 19.2	Below other side in eighths
D. .	To one side in eighths	Find weight in pounds.

What is the weight per foot of a bar 2 inches by 3/8 inch?

C...	Set 19.2	Under 3 (eighths)
D. .	To 16 (eighths)	Find 2.5 pounds.

10. *Weight of boiler plates per square foot.*

C...	Set G. P. 40	Below thickness in 32ds
D. .	To G. P. 50.5	Find pounds per square foot.

The thickness must always be taken in thirty-seconds of an inch.

The above are, I believe, the simplest methods for obtaining the weights of wrought iron bars and boiler plates, which have been brought out.

11. *Weight of pipes.*

C...	Set G. P. 0.405	Below difference of inside and outside diameters in inches
D. .	To sum of inside and outside diameters in inches	Find pounds per lineal foot.

The above is for cast iron pipes; if of wrought iron, use gauge point 0.382. Fractions of inches must be taken in tenths, decimally.

12. *Specific gravity.*

C...	Set 1	Find weight of 1 cubic foot
D. .	To 0.016	Above specific gravity.

13. *Discharge of single-acting pumps.*

A...				Find gallons per minute
B... C...	Set 294	R to number of strokes per minute	1 to R	Over length of stroke in inches.
D. .	To diam. in inches			

It must be borne in mind that 294 is to be found in the left scale B of the slide.

14. *Average pressure of steam.*

The average pressure of steam in pounds per square inch for the whole stroke, with the steam cut off at any point, is very easily found by

C...	Set initial G. P.	Under initial pressure
D. .	To average G. P.	Find average pressure.

The initial and average gauge points are to be taken from the following table:

Cut-off	7/8	3/4	5/8	1/2	3/8	1/4	
Initial G. P.	250	55	37	13	82	57	
Average G. P.	248	53	34	11	61	34	
Cut-off	1/8	5/6	2/3	1/3	1/6	9/10	8/10
Initial G. P.	65	68	16	10	43	200	139
Average G. P.	25	67	15	7	20	199	136
Cut-off	7/10	6/10	4/10	3/10	2/10	1/10	
Initial G. P.	139	167	214	3	23	100	
Average G. P.	132	151	164	2	12	33	

The advantage of the above table is that there are distinct divisions on the slide and the rule for every figure, so that there is no need to estimate the position of any of them.

Given an initial pressure of 60 pounds, with cut-off at three-eighths of the stroke, what is the average pressure for the whole stroke?

C...	Set I. G. P. 82	Under 60 pounds
D.	To A. G. P. 61	Find 44.6 pounds.

This is also convenient for arithmetical calculation, thus above example,

$$\text{Average pressure} = \frac{60 \times 61}{82} = 44.6 \text{ pounds.}$$

15. *Horse power of a steam engine.*

The simplest method of obtaining this is as follows:

A...				Find horse power
B... C...	Set 1	R to piston speed	42000 to R	Over pressure.
D. .	To diameter			

Example: Cylinder 8 inches diameter and 14 inches stroke, 90 strokes per minute = 210 feet piston speed, 50 pounds pressure of steam.

A...				Find 16 H. P.
B... C...	Set 1	R to 210 feet	42000 to R	Over 50 pounds.
D. .	To 8 inches			

If, however, the engine constant for a uniform rate of speed be calculated, the horse power corresponding to any steam pressure may be obtained with one operation. Thus, in the above example, the engine constant C is

$$\frac{LAN}{33000} = \frac{8 \times 8 \times 0.7854 \times 14 \times 180}{12 \times 33000} = 0.32$$

The horse power is then equal to $C \times P$, so that we have for the slide rule

C...	Set 1	Under any pressure
D. .	To engine constant	Find horse power.

If all the above examples are carefully worked out, and the reasons for each step studied and thoroughly mastered, the solution of any similar problems should be an easy matter. It must, however, be borne in mind that the slide rule does not profess to give absolutely accurate results; indeed, from its very small dimensions, and from the amount of estimating that has to be done, this could not be expected; with a *good instrument*, however, and practice, errors of more than one in five hundred should not occur often, the general average being about one in two hundred, although in many cases and with care in setting the slide and runner, much greater accuracy may be obtained.

Another point to be noted is that each one must use the slide rule for himself and for his special work. He should therefore seek short-cuts by the use of gauge-points and constants, which must be calculated out and should all be noted for future use. Examples 1, 5, 7 and 9 to 15 are all examples of the use of gauge-points and constants, every one of which has been calculated by the writer. It is in this way that the slide rule can be used to advantage. It would also be helpful if each reader would try and discover how the gauge-points in the above examples have been obtained. Just a hint: some of them are direct results, while others, to facilitate their use with the slide rule, are reciprocals.

* * *

NOTES FROM THE A. S. M. E.

The last meeting of the society was highly successful in many ways and much valuable information was as usual made public.

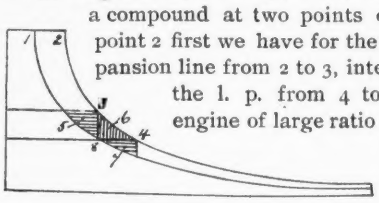
Mr. Scheffler's paper on steam boilers and piping elicited much comment and numerous suggestions. Mr. Emery advocated check valves being placed in the steam pipes where they enter the main, so as to prevent steam flowing from the main to the boiler in case of accident. The outlets for entrained water should be placed so as to drain *with* the flow of steam, as it never drains the other way. Mr. Supplee called attention to the advantages of a large feed heater, which acts as a purifier, while small ones fail to perform this important service. Providing a circulation in the blow-off was suggested as a prevention against burning out as they so often do.

The preservation of clippings and similar small bits of information was widely discussed, the majority seeming to favor the use of envelopes of various sizes if necessary, filed and indexed in such a way as to be readily accessible.

Tests of cast-iron were given by Messrs. Henning and Keep, who conclude that the sizes of bars used does not necessarily affect the relative results, while Mr. West takes the opposite view and advances other ideas in opposition to those of the gentlemen named.

The committee on gages reported in favor of using thousandths of an inch for all wire and sheet metal, and the suggestion by others, of using the word "mil" instead of "thousandths of an inch" seemed to find favor; as being shorter and in accord with the practice of electrical engineers. This is one of the most rational steps taken in this direction and the society is to be commended on its action. Mr. F. W. Dean's papers on compound engines attracted considerable attention, showing some very economical work in both the Louisville engine and that on the Rockwood system at Natick, R. I., the former being 12.156 and the latter 12.84 pounds per I. H. P. per hour. The papers were evidently intended to show the fallacy of the latter system and the rather strange conclusion was reached that the high economy of this engine was not due to the system but was rather in spite of it, the drop in pressure between cylinders being considered a grave defect. Mr. Rockwood replied with one of the best written papers of the convention and stated his side of the question very clearly, showing that the drop in pressure was not so much of a loss as might be imagined and had practical advantages which were in its favor. The back pressure on the h. p. cylinder is reduced and though the temperature range is increased in the h. p. cylinder over what it would be with the intermediate cylinder in use, this has such a small surface as compared to l. p. cylinder (the ratio of cylinder area in this case being 7 to 1) that the condensation is really less by so doing than the intermediate cylinder would cause, making the well taken point that the condensation depends on the temperature

range and the surface exposed, and not on the temperature alone, as might be inferred from some of the expressions. He also showed that if the Leavitt engine had been provided with a large receiver, the range in temperature of the l. p. cylinder walls would be less without any increase in temperature range of the h.p. cylinder walls. A simple diagram which he drew in connection with the discussion on triple engines for variable loads, will make the advantages claimed for the large ratio system clear, as these are not as generally understood as they should be and Mr. Rockwood's work in this line deserves to be better known and those who want indorsement by high authority, can be told that Mr. Chas. T. Porter is an advocate of the large ratio compound as preferable to the triple engine.



The diagram shows the combined cards of a triple engine and a compound at two points of cut-off and considering point 2 first we have for the triple engine the h. p. expansion line from 2 to 3, intermediate from 3 to 4, and the l. p. from 4 to the end. The compound engine of large ratio (being really a triple minus the intermediate cylinder, which is replaced by a large receiver) would give a h. p. expansion line from 2 to 3, here drop vertically to 8 which gives the back pressure line for the h. p. The l. p. expansion is from 4 down, as with the triple, giving the triangular area marked 6 as the theoretical loss from drop in receiver.

Shortening the cut-off to 1 we have the negative loop 5 on the h. p. and a similar loop 7 on the intermediate, representing far more loss than the receiver drop in the first case. But the compound under this shorter cut-off shows practically no drop, and the h. p. expansion line ends where the l. p. begins at eight as shown, illustrating the range of work of the large ratio compound, which is much larger than usually supposed.

Mr. Porter's high speed, small clearance, cam actuated, piston valve engine was decidedly ingenious and has many good points; while his governor, steam separator and jacket are also highly commendable, but lack of space forbids an illustration.

THE paper on counter-balancing locomotives, by Prof. Goss of Purdue University gave interesting results and showed ingenious methods. The locomotive drivers were mounted on rollers of the same size and a small soft iron wire passed between them, the vertical action of the counter-balance being shown by the various sizes of the wire after passing through. Results showed that wheels as usually balanced (all revolving parts and from 40 to 80 per cent of reciprocating parts) cannot leave the rail unless speed is excessive. When wheels are lifted, the rise is slow and descent rapid, the maximum lift occurring after counter-balance has passed highest point.

Mr. G. M. Sinclair presented some very interesting notes on steel forgings, in which much information was imparted. Oil tempering and then annealing is recommended for high-class work, and thorough annealing is deemed necessary for all forgings—double annealing being often neccessary for best results. This is best done in suitable furnaces where the steel can be gradually cooled, although lime or such annealing is better than none.

AN interesting account of straigthening a chimney which leaned about 28 inches was given by Mr. Jos. C. Platt. Cables were fastened around the chimney just below its center of gravity, and excavations made around the high side with the result of bringing it back to place in the course of six or eight weeks.

THE much discussed question of engine clearance received additional data from Mr. G. W. Bissell, a 4½ x 9 inch slide valve engine being used.

This was tested with 8.27, 11.56, 14.36, 17.82, and 19.91 per cent of clearance, with the rather surprising result of showing the best economy of steam at 14.36 per cent clearance, tending to confirm the belief that in all cases clearance is not necessarily detrimental to an engine's economy.

AN interesting feature of the discussion on a rustless coating for steel was the fact that the armor plates of the old monitors were badly corroded in spite of paint and for a distance above the water line equal to the depth of immersion of the plate below it, galvanic action being the attributed cause for the phenomenon.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

FORMULA FOR POLYGONS.

The following I think will make a handy extension to the formula published in October number, page 6:

$$S = 2\,R \sin\frac{180^0}{n} = 2\,r \tan\frac{180^0}{n}$$

$$A = \frac{n}{2} R^2 \sin\frac{360^0}{n} = n\,r^2 \tan\frac{180^0}{n} = \frac{nS^2}{4} \,\mathrm{co\,tan}\frac{180^0}{n}$$

POLYGONS.

S=Side of polygon.
R=Radius of circumscribed circle.
r=Radius of inscribed circle.
n=Number of sides.
A=Area of polygon.

n	R	r	S	A
3.	0.577S	0.289S	1.732R or 3.463r	$0.433S^2$ or $1.299R^2$
4.	0.707S	0.500S	1.474R " 2.000r	$1.000S^2$ " $2.000R^2$
5.	0.851S	0.695S	1.176R " 1.453r	$1.721S^2$ " $2.378R^2$
6.	1.000S	0.866S	1.000R " 1.155r	$2.598S^2$ " $2.598R^2$
7.	1.152S	1.038S	0.868R " 0.963r	$3.634S^2$ " $2.736R^2$
8.	1.307S	1.208S	0.765R " 0.828r	$4.828S^2$ " $2.828R^2$
9.	1.462S	1.374S	0.684R " 0.728r	$6.182S^2$ " $2.892R^2$
10.	1.618S	1.540S	0.618R " 0.649r	$7.694S^2$ " $2.939R^2$

Black Rock, Conn. H. HEYRODT.

PRINCIPLES OF MACHINE DESIGN.

I have read Prof. Benjamin's article on "General Principles of Machine Design" with unusual interest, but beg to take exception to the statements wherein he says "the use of a cabinet at one end and legs at the other is inharmonious and offensive to the eye." I simply wish to place my opinion against his and say thas it is nothing of the sort; that the cabinet at one end and the pivoted leg at the other is right and looks right, and looks right because it is right. The cabinet at each end, unless fitted with a cradle, as he mentions, never was right, and unless that cradle part is conspicuously visible can never look right. Nor is the tail stock end of the bed the right place for that support. I do not question but very ugly designs may be worked around this this idea of a single cabinet support under the head stock of a lathe and the pivoted leg out where the average position of the tail stock comes, still it will not be because the leading idea is wrong, but from the lack of something on the part of the designer.

I do not care to take part in a controversy, though hope that others will take it up, as *good* is pretty sure to come from it.

Syracuse, N. Y. JOHN E. SWEET.

"LEARNING A TRADE TO FALL BACK ON."

I note your editorial under the above heading, and heartily indorse all you say. Out of it comes another thought. It has been a standard and a standing delusion for so many years that there is no way of getting back to the beginning, that when a man finds himself a failure as a lawyer, doctor, minister, or what not among the occupations termed "professional," mainly because the term has no meaning outside the dictionary, he can turn his attention to a trade with good prospects of success. If ever there was a snare and delusion in human affairs it is right here. The machinists' business has, perhaps, suffered the most from this, because in its wonderful ramifications there are the most allurements.

It is always possible that a man has studied one of the professions when his natural bent was toward mechanics; circumstances which he could not control may have shaped his course. It is equally possible that such a man may successfully change his vocation. But if this man has studied a profession because he had a liking for the work attendant upon following it, but fails for lack of head capacity, he will never succeed as a machinist. He may rattle around in a machine shop, but he will always be a "loose fit." He will never be a successful machinist, not even if he has previously devoted three or four years to "learning a trade to fall back on."

The idea that it does not require as many brains to enable one to become a thoroughly successful machinist as it does to become an equally successful professional man, is a fallacy born of inability or disinclination to discriminate as to what constitutes education. It does not require much in the way of brains to

learn a little Latin and Greek and the like, which may be rather essential to the professional man. The mechanic has no use for these, and very likely has expended none of his vital force in that direction. It would not help him to manipulate the tools in the shop, nor to design machines and machinery. He has spent years of his life in studying the things pertaining to his trade, yet he is described as uneducated. It is the glamour of being able to "talk in many tongues" that leads most people to believe that some special brain-power must, perforce, be a part of the capital of the professional man.

If you run a first-class mechanic up against a Latin quotation the chances are that he will fail to comprehend it. But if you confront the doctor, the lawyer, or the minister with almost any of the simple problems that daily come up to the mechanic he is quite as much in the dark. I make in this the same distinction between the mechanic and the man that works at the trade that I do between the doctor—the real physician—and the man who practices medicine. This distinction should be made, because it actually exists.

Education is of different kinds as well as different in degree, and only a small part of it is a matter of books. F. G

BALL BEARINGS IN PROPELLER SHAFTS.

Up to the present time balls have not been used very extensively in the thrust bearings of propeller shafts. There are many reasons for this, among which are, First—The cost of making a proper bearing for this purpose; Second—A lack of confidence in the owners of vessels in regard to the durability and in some cases the utility of the device.

There are several instances in which there have been failures after a few months use and this has prevented a more general use of such a bearing.

There are many small steam launches now made having ball bearings in the propeller shaft by which they obtain a speed of one or two miles per hour more with the same expenditure of power than a boat having the plain thrust block.

Cleveland, Ohio. JOHN J. GRANT.

Note—We referred an inquiry on this subject to Mr. Grant, probably the best authority on ball bearings in the country. [ED.

METHOD OF FIRING.

I wish to point out that the method of firing advocated in the article "Looking Backwack," in October MACHINERY—viz., reducing boiler pressure by putting on fresh coal and closing ash-pit doors and dampers is dangerous practice when using a lignite coal or any coal containing much volatile combustible matter. For when fresh coal is thrown into the hot furnace the gas is at once liberated from the coal and accumulated in combustion chamber and flues: then when the ash-pit doors are opened fresh air rushes in, unites with the gas and forms an explosive mixture which ignites with violence. I have known the doors of the boiler front to be blown open in this way with such force as to burst the water column and *scare* a fireman even in this latitude.

Deadwood, S. Dakota. N. M. BARKER.

PUMP CYLINDERS

"Lining Pump Cylinders," as contained in your October issue is interesting to the writer, as he has had some experience in this line himself.

A mine pump was brought to his place of business with the remark that it probably needed a new lining, which it certainly did. In this case it was decided to shrink the lining in; the cylinder was heated sufficiently to give the required expansion and the lining dropped in—but it didn't drop, it went about three-quarters of its way into the pump and stuck fast. The lining had become sufficiently heated to expand tight. It was evidently a case of either "haste or waste" and we adopted the former and avoided the latter—fortunately it was exceedingly cold weather and icicles of immense size and length were hanging in profusion from the eaves of the blacksmith shop, a quantity of these were hurriedly collected and packed into the obdurate lining and in less time than it takes to tell it the job was done. That lining dropped to its place beautifully without striking a blow. We have had occasion to shrink linings in since, but we now plug the lower end and fill with water. H. P. CLARKE.

Washington, D. C.

* * *

Mechanical Drawing;" Walter K. Palmer, M. E.; 50 pages; 80 cents. Chas. B. Palmer Publisher, Columbus, Ohio.

This little book is intended as a teachers' and students' assistant, rather than a text book, and will be found most useful in connection with a regular course of drawing.

SAFE SPEED FOR IRON PULLEYS.

In high speed machinery, especially wood-working and grinding machinery, the high speed demanded strains the rims of driving pulleys almost to bursting, and many accidents have resulted from this cause. A little calculation will show us the limit of rim speed for cast iron pulleys, and this should not be exceeded under any circumstance. The stress per square inch of section of pulley rim equals $\frac{1}{10}$ of the square of the velocity in feet per second, and with 5 as a factor of safety, we can allow 2,000 pounds as the safe stress per square inch, which assumes the cast iron to withstand a tensile load of 10,000 ($5 \times 2{,}000$) pounds per square inch. Then our velocity can equal the square root of the safe strain (2,000) divided by $\frac{1}{10}$. Putting this in formula shape, which is so much simpler than long written rules, gives us

V=velocity of rim in feet per second.

S=stress per square inch of section of rim.

Then

$S \quad V^2 \times .1$ and $V = \sqrt{\frac{S}{.1}}$ or $V = \sqrt{\frac{2000}{.1}} = \sqrt{20000} = 141.4$

feet per second, or 8,484 feet per minute. Working this backwards, or by the first formula, we have $S \quad 141.4^2 \times .1 = 2{,}000$. These simply involve square root, which any mechanic can readily understand from any arithmetic.

* * *

MANUFACTURING NOTES.

THE MERIDEN MACHINE TOOL CO. have just made arrangements with the Pennsylvania Supply Co., of Wilkes-Barre, Pa., to represent them exclusively in Lackawanna, Luzerne, Schuylkill, Dauphin, Carbon, Columbia, Montour, Wayne, Wyoming, Sullivan, Northumberland and Susquehanna Counties in Pennsylvania, and all inquiries from these counties regarding their Forming Lathes and Tools should be addressed to them.

ONE indication of better times among machine tool builders comes from the John Becker Mfg. Co., Fitchburg, Mass. This company is busier than they have been for three years, their orders for December being about $2,000 more than for the corresponding month in '93.

THE BUILDERS' IRON FOUNDRY, of Providence, R. I., announce the publication of a new pamphlet in the near future, describing their Venturi Meter in "every day" language, which will be better understood by those not familiar with formulæ and technical terms than the one first issued.

MOST engineers and designers having numerous calculations, know the value of the slide rule, and its use, we are glad to note, is becoming more common. The one made by the A. W. Faber Co. is a very handy form of slide, or "Calculating Rule," and will save much time and labor after a little study of its principles, which are easily mastered.

THE JOS. DIXON CRUCIBLE CO., Jersey City, are making phosphorous chargers of plumbago, which render the charging of phosphorous into molten metal, in the manufacture of phosphor-bronze, etc., an easy matter. Foundrymen will appreciate this, as it relieves them of considerable care in mixing these metals.

CHANDLER & FARQUHAR, of Boston, have united their two stores—one on Washington street near Dock Square, which was devoted to the sale of small tools and supplies, and the other on Purchase street, used for their machine tool business—in a large and conveniently located store at 34 and 36 Federal street, extending through to Congress street. They are now situated almost in the center of the machinery district, and are admirably equipped to reach that trade.

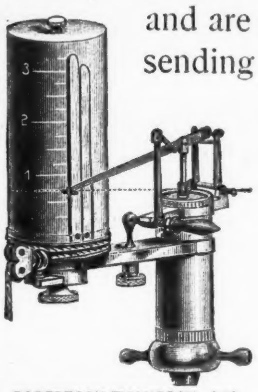
THE GEORGE BURNHAM CO. (Frank Reed, proprietor), of Worcester, Mass., have issued their 1895 catalog of drills, a large variety being shown, mostly for light work. The styles include blacksmiths' and wheelwrights' drills, post drills, bench drills, and a number of multiple spindle drills.

THE BOSTON GEAR WORKS' catalog gives about all forms of gears and gear teeth that ordinary or special cases are apt to require. Chains for transmitting power are also shown and in sizes varied enough to suit many classes of work. The heavy machine-made chain is especially suited for power requirements,

THERE are many evidences of a change in public sentiment in regard to safety water columns for steam boilers, and oddly enough, it comes from the South, which has become very progressive within the past few years. Many years ago there was a very general idea that such appliances were not practical, and perhaps an equally general idea that at best they made attendants careless; but experience has shown that they are not only practical in operation, but that they have just the opposite effect on attendants, making them extremely watchful instead of careless. The Dixie Fair Association, which recently held the Georgia State Fair at Macon, awarded a premium of $50.00 for the "best high and low water alarms in actual operation," which naturally went to the Reliance Safety Water Columns, manufactured by The Reliance Gage Co., Cleveland.

The New York Central System was the nestor of fast passenger service in the United States. Away back in 1878 that road was running "flyers." The "White Mail" was put on in 1876, and ran between New York and Chicago in nearly as fast time as is now made between these cities. This train, however, did not carry passengers, though there was, even at that time, a fast passenger service in operation over these roads. The train was called the "Lightning Express," and made the trip from New York to Chicago in about twenty-six hours. The "White Mail," as it was called, was the admiration of the whole country. Four snow-white mail cars made up the train, and the farmers used to stop work when it passed. Indeed, there was a rumor to the effect that this train only hit in high places. Soon after this the New York and Chicago Limited was put on. This was the first all-sleeper train ever run, and some doubt as to patronage was indulged in by the officials. But this question settled itself The train paid from the beginning, and it was soon followed by other fast all-sleeper trains. But the other roads have always waited on the Central, and we owe the comfortable train service throughout the country to the enterprise and pluck of the New York Central System.—"DIXIE."

We have made a deal with "Machinery,"



and are able to offer a year's paid up subscription to this paper to every person sending us in an order for our goods, or goods in our line, no matter what size the order may be. It should not be much trouble for you to find something in this list you need. . . . . Our line comprises:

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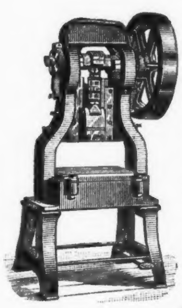

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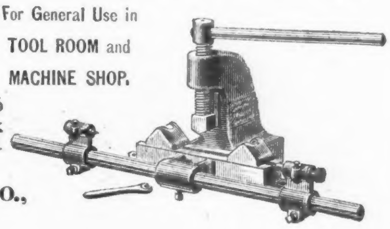

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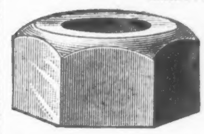

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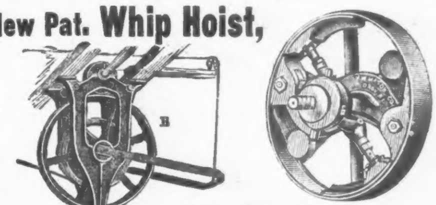

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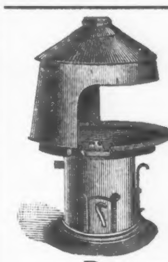

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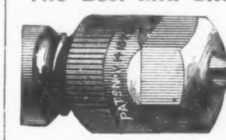

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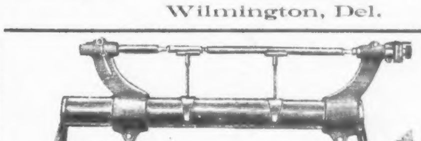

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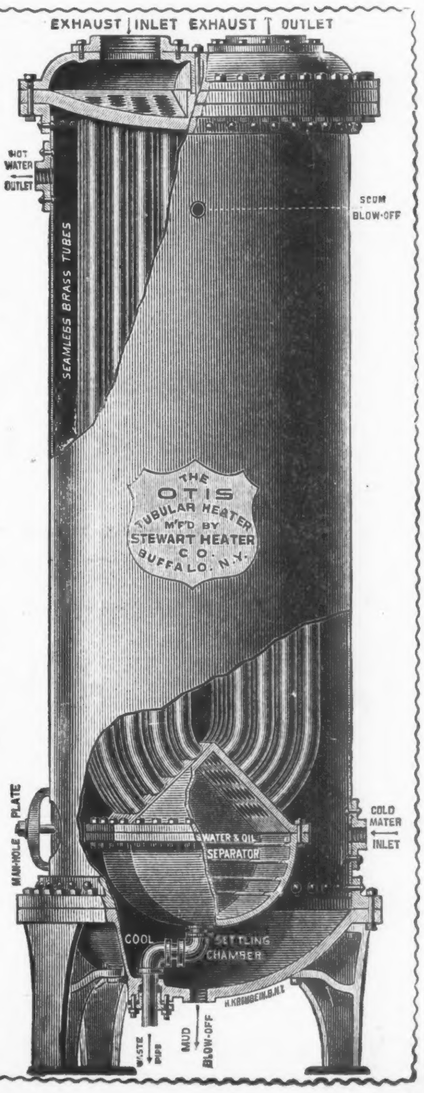

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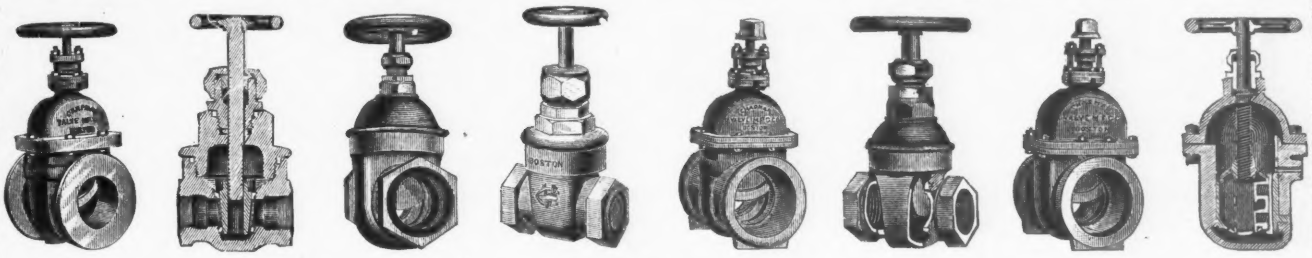

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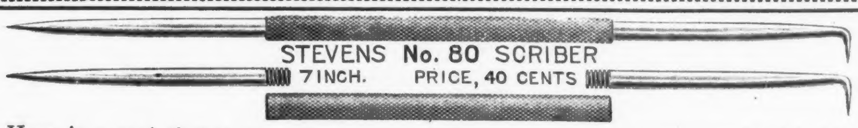

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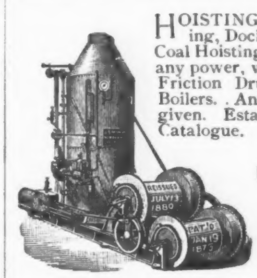

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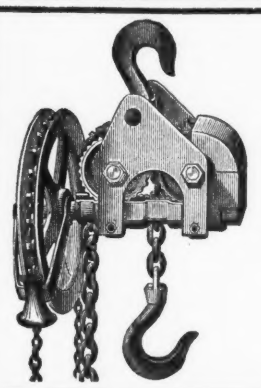

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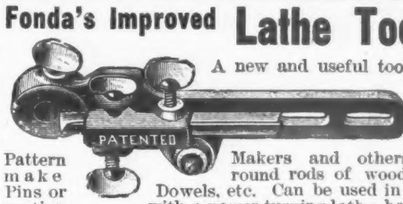

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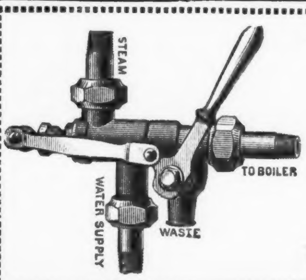

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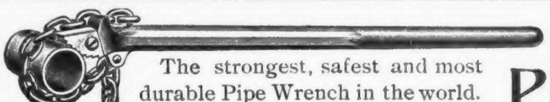

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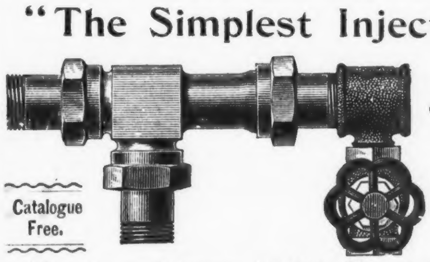

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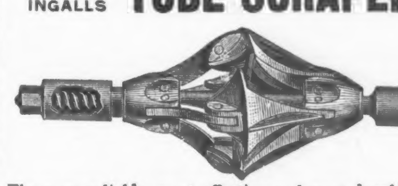

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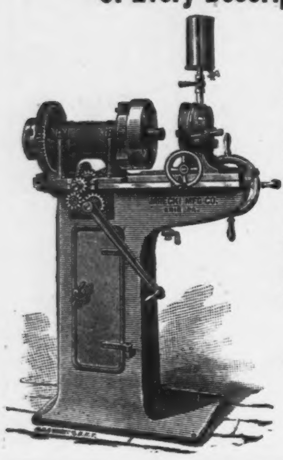

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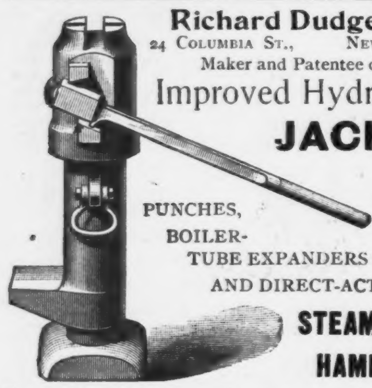

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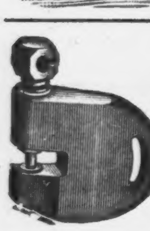

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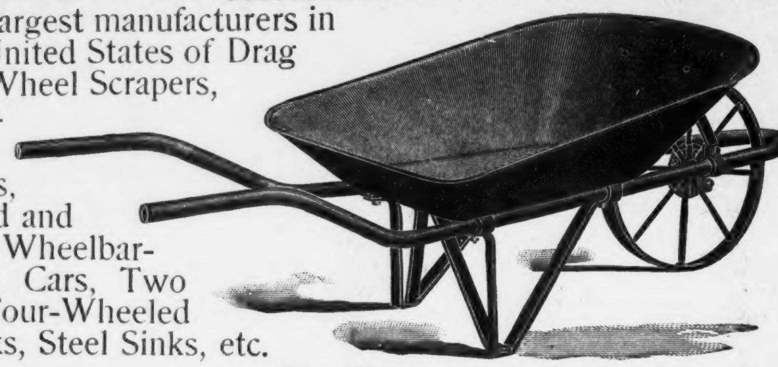

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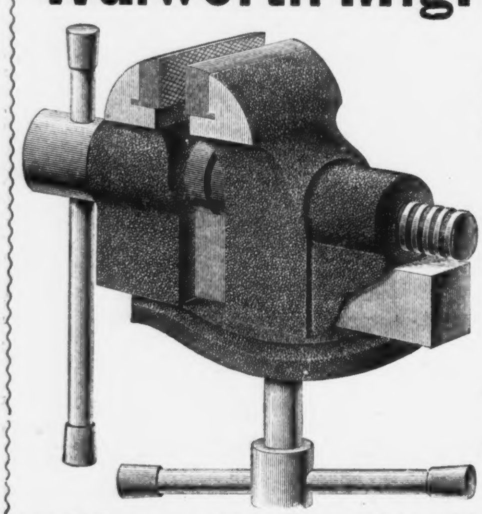

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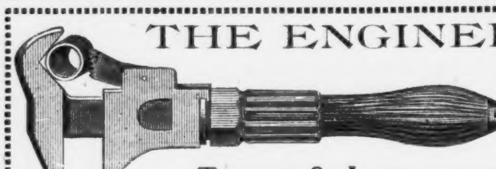

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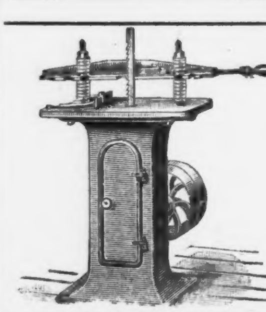

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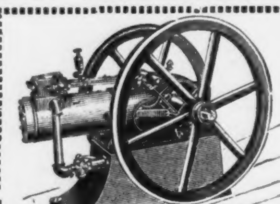

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